THE JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

EDITED BY

SIR R. A. SPENCE, KT., S. H. PRATER, C.M.Z.S.
& SALIM A. ALI, M.B.O.U.

VOL. XXXIII

Nos. 1 & 2

Containing 2 Coloured Plates, 56 Black and White Plates,
41 Text-figures, 30 Diagrams and 2 Maps

Dates of Publication

Part I. (Pages 1 to 221) ... 30th September, 1928.
,, II. (,, 222 to 471) ... 15th February, 1929.

LONDON AGENTS

DULAU & Co., Ltd., 32, Old Bond Street, London, W. I.

PRINTED AT THE DIOCESAN PRESS, MADRAS.

1929

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ERRATA

Vol. XXXII, p. 694, Upper figure—Instead of *Nilum* read *Hilum*.

General Index of subjects and authors—Vols. XXV-XXX inclusive, p. 16: Burton, Col. R. W.—add at the end of the para.—A few days after Urial in the Punjab, XXX 838.

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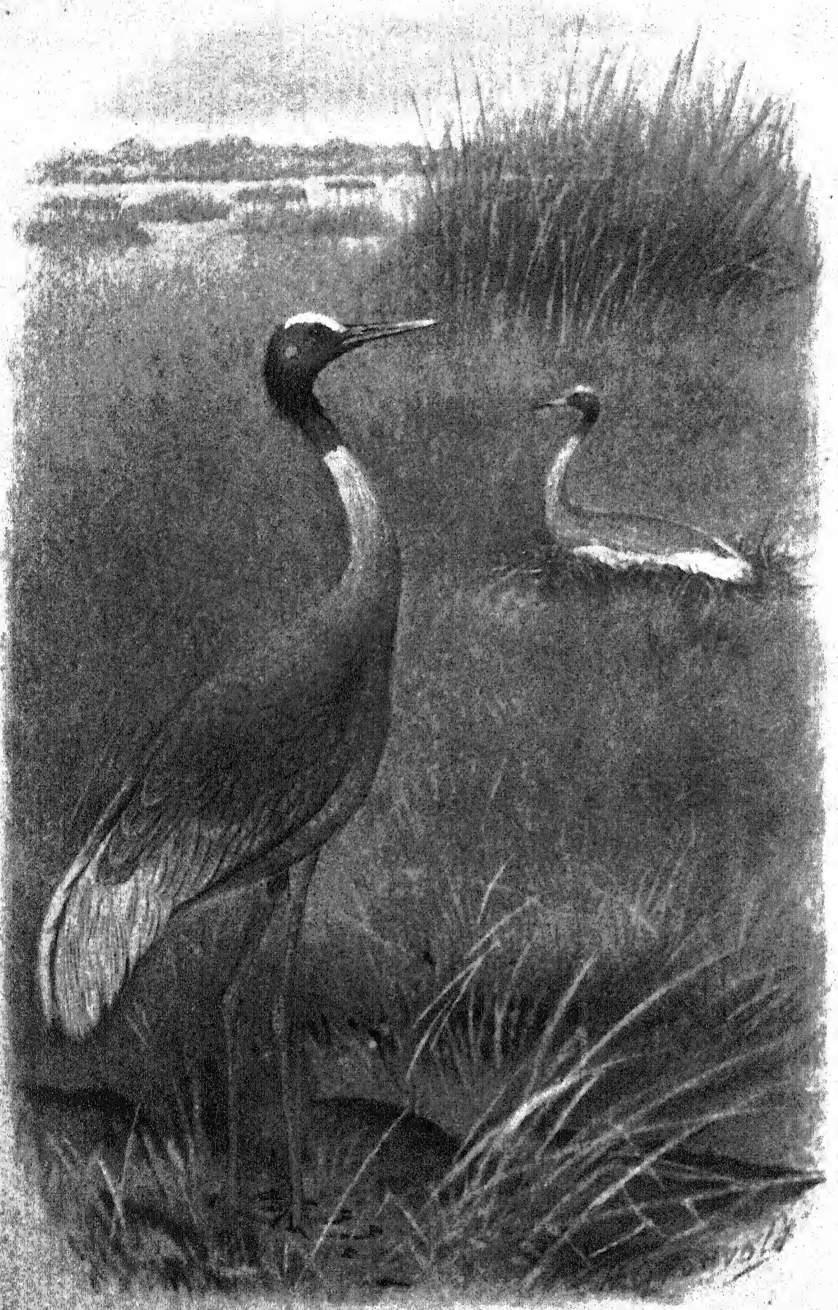


THE SARUS CRANE
Antigone antigone antigone
1/11 Nat. size

JOURNAL

OF THE

Bombay Natural History Society

SEPTEMBER VOL. XXXIII No. 1

THE GAME BIRDS OF THE INDIAN EMPIRE

BY

E. C. STUART BAKER, F.Z.S., F.L.S., M.B.O U., H.F.A.OU.

VOL. V

THE WADERS AND OTHER SEMI-SPORTING BIRDS

PART VII

(*With a coloured plate*)

(*Continued from page 621 of Volume XXXII*)

Genus—ANTIGONE

Antigone Reichenb. Handb. Sp. Orn., p. xxiii (1852).
Type.—Grus collaris Bodd.—*Ardea antigone* Linn.

The genus *Antigone* differs from *Megalornis* in having nearly the whole head and neck bare, the hind neck, face and chin covered with coarse granulations.

ANTIGONE ANTIGONE

Key to Sub-species

A. Paler, a ring round the neck and long inner secondaries white ... ... *A. a. antigone*, p. 2
B. Darker, no ring round the neck and long inner secondaries grey ... ... *A. a. sharpii*, p. 5

ANTIGONE ANTIGONE ANTIGONE

The Indian Sarus Crane

Ardea antigone Linn., Syst. Nat., 10th ed., p. 142 (1758) (India, Hartert).

Grus antigone.—Blanf. and Oates, iv, p. 188.

Vernacular names.—Saras, Sirhans (Hind.), *Khur-sang* (Assam).

Description.—A patch of grey-white feathers on the oral region; a ring round the upper neck and a patch on the throat of black bristly feathers; a few coarse bristles on the lores; remainder of head and neck bare, the crown smooth, the rest of the naked parts covered with coarse granulations; a ring of white feathers next the base of the bare neck; winglet, primary coverts and primaries black; remainder of the plumage pale grey becoming almost white on the lengthened inner secondaries.

Colours of soft parts.—Iris orange; bill pale greenish-horny with dark tip; legs fleshy red to livid red or red; bare skin of crown and lores ashy-green or glaucous green; the papillose skin of head and neck orange red becoming much deeper and brighter in the breeding season.

Measurements.—♂ wing 670 to 685 mm.; tail 255 to 263 mm.; tarsus about 310 to 355 mm.; culmen 172 to 182 mm.; ♀ rather smaller, wing 625 to 645 mm.

Young birds have the whole head and neck covered with short buff, or rusty-buff feathers.

Nestlings are covered with rich deep brown down above, more rufous and lighter on sides and on the head, and paler below.

Distribution.—Northern India from the Indus to Western Assam (Gowhati); south to Bombay Presidency on the west as far as Khandesh and to the Godavery River on the east.

Nidification.—The Sarus Crane breeds after the rains have well set in, that is to say from July onwards. Most eggs are laid between the middle of that month and the end of August but many are laid in September. From then until the end of November casual nests and eggs may constantly be found whilst I have one clutch from the Central Provinces taken in March, a most unusual time. Pershouse took a nest with single egg in December and Captain E. O'Brien found a newly hatched young one on February 12. The birds generally select for their nesting site some piece of ground entirely surrounded by water or by swampy marsh land, but occasionally will lay in comparatively dry open plains. Concealment never seems to be aimed at, rather they choose a place from which they can see danger from afar off. Jackals and other vermin have no terrors for these birds for they can protect eggs and young so long as they can see their enemies coming and get back to their nests in time. Even of man they have but little fear and stick to their nests until very closely approached. Hume tells an amusing tale of a pair of birds whom he sent his '*syce*' to rob of their eggs. "As he commenced wading towards the nest the male began to dance about, flapping his wings and trumpeting most bravely; but when the man got within a few yards and landed safely on a patch of dry ground on which the nest rested, the male put his head down and ran off very

crestfallen to a ridge in the water some fifty yards distant, whence he began with loud cries to encourage his lady not to allow 'that black rascal' to take any liberties. She sat quite still neither moved nor cried, only as the man came close to her made such vigorous pokes and drives at him that he got frightened and was picking up a great dry branch to strike her with, when I called out to him to flap her in the face with his waistcloth. This he did vigorously and this being more than she could endure, she relunctantly crept off the nest, now complaining loudly and joined the male.' There was only one egg ; this the man brought, but before he could reach me the female had regained the nest, and after minutely examining it and making certain the egg was gone, she stood on the top and with bill, legs, and feet commenced throwing the straw about in the air in the most furious manner as if beside herself with rage. Then the male came up trumpeting, but directly he came near she flew at *him*, and he scrambled off, half running half flapping, through the water, and making more noise than ever." The egg, nearly hatching, was restored to the nest and the female was down upon it before the man had left the island.

In curious contrast to this account is one narrated by Captain O'Brien who handled a young one whilst both parents remained about 30 yards away, showing no signs of anxiety. Even when Mrs. O'Brien joined him and inspected their baby the old birds did not seem to object, though later when a kite came near the nest they both attacked it. As Captain O'Brien remarks that evidently the old birds knew their real enemy.

The nest varies considerably in size. It is made of straw, rushes, grass and all sorts of rubbish and is often added to when floods threaten it with swamping. Nests have been measured as much as nine feet across the bottom, three feet across the top and three or four feet high. Other nests built on comparatively dry ground may not be more than two-feet across and a few inches high. The eggs laid are normally two, but one only is frequently incubated and even when two young are hatched it is seldom that more than one survives for more than a few days. They are quite unlike the eggs of the genus *Megalornis*. The ground colour is white, exceptionally tinted with reddish or sea green; some few eggs are quite unspotted but most are sparsely blotched with light reddish, deep reddish-brown or purple-brown with others equally scanty, of pale lavender or reddish-grey. In about one egg in every dozen or so the blotches are bolder, more numerous and darker and consequently the eggs are more handsome. In shape they are long pointed ovals and in texture very strong and coarse but the surface is smooth, often highly glossed, and is invariably covered with tiny pits or pores which collect the dirt and give a speckled appearance to the egg. One hundred eggs average 104·4 × 64·3 mm. ; maxima **113·2 × 69·8 mm.** ; minima **93·2** × 65·0 and 105·5 × **53·8 mm.**

Habits.—The Sarus Crane is resident wherever found and is always to be seen in pairs, sometimes accompanied by one or two young. Occasionally they may be seen in small flocks but even in these instances the pairs keep together and flocks are but rarely seen except in the driest seasons or in droughts when necessity drives

many pairs to places where there is still enough water left to satisfy their wants. They are essentially birds of the well-watered plains and keep away from hills and broken country or from widespread dry and desert areas. On the other hand the swamps and lakes often satisfy their needs altogether and they wade their existence away without resort to dry land except for nesting purposes. They pair for life and are very devoted mates so that if one is killed it is said that the survivor often dies of grief. Hume comments on this and points out that if specimens are required for skins or if food is needed for servants, etc., it is better to kill both male and female than to let one go. As game birds, however, no one can possibly wish to shoot them. They are so tame that stalking them affords no difficulty and therefore no pleasure, their flesh is not in any way desirable, even if eatable, whilst the delight of watching the birds is more than enough to compensate the greediest of slaughterers for the loss of a shot. Their flight is powerful and by no means slow but they rise off the ground with difficulty, generally running some yards with flapping wings until they gain sufficient impetus; once started, however, they fly great distances with ease, though the flight is noisy and generally close to the ground, seldom more than fifty feet from it and often far less. They never soar as the Cranes of the preceding genus do and their flight is inferior in every way to that of these migrating birds. It should be noted that Osmaston twice saw these cranes flying in flocks, once of 20 and once of 24 birds and that in the former case they adopted the 'V' shape flight and in the second flew in a long line. On foot, they are even better performers than other cranes and often walk considerable distances over plains and shallow swamps to favourite feeding places, stepping along with care and no little grace of movement. Like all cranes they indulge in all kinds of fantastic dances which are not graceful or conducted in the deliberate, rather dignified style of their normal walk. These dances are indulged in by both sexes, more often, but not only, in the breeding season. The cock bird usually starts the performance by picking up a straw or branch in his bill and then strutting with a dancing motion towards his lady love. When within a few feet of her he bows, throws his head back, trumpets and with wings outspread dances a *pas seule* of half a dozen steps, each leg lifted high and quickly into the air, accompanied by a hop off the ground; a few bowings and tossings of the head follow and then once more some steps. This may go on for a few minutes, the female joining in or not as the mood seizes her, and then suddenly both recommence feeding. Their food consists of all kinds of grain, shoots, aquatic plants, frogs, lizards, insects, etc. and they feed alike in shallow water up to 18 inches deep and in cultivated fields and open plains. Two or three pairs in a field of young wheat or rice are said to be capable of doing considerable damage, though this can never be compared with the destruction of crops by a mighty flock of Common or Demoiselle Cranes.

Their call is a loud sonorous trumpet uttered chiefly in the mornings and evenings and through the night, when the birds of a pair, separated in the darkness, call constantly to one another.

The young remain with their parents until they are nearly full grown and the latter desire to think once more about their annual domestic arrangements. They are affectionate, quiet and gentle birds in a state of nature but make bad pets, domesticated birds often being very savage and actually dangerous with children, attacking them fiercely and endangering their eyes.

Antigone antigone sharpii

The Burmese Sarus

Grus sharpii Blanf., B.O.C., v, p. vii (1895) (Burma); Blanf. and Oates, iv, p. 189, (part).

Vernacular names.—*Gyo-gya* (Burm.); *Khior-sang.* (Assam). *Wdnu, Woinuren* (Manipur).

Description.—The plumage generally rather darker than in the preceding race. There is no white ring of feathers at the base of the neck and the inner secondaries are practically the same colour as the back.

Colours of soft parts as in the Indian Sarus.

Measurements.—Wing 600 to 675 mm.

Distribution.—Assam east of Kamrup, Burma, Siam and Cochin China. Specimens from Penang may probably have not been wild birds.

Nidification.—Nests and eggs of this Crane so exactly resemble those of the preceding bird that no further description of them is needed. The country in which they are found, however, sometimes differs in being much more forested. In 1902–3 Coltart noticed a pair of these birds constantly frequenting a wide open space in the forest on the Dehing River. This place, perhaps half a mile across or a little more, was entirely surrounded by virgin forest and in the cold weather was dry and covered with short grass a foot or so high with a deep swamp in the centre much frequented by Wood Duck. In the rains practically the whole area was under water exept for small islands of rather higher land. On one of these the Cranes had constructed their cone-shaped nest and on June 19 when I went to see if they had thoughts of nesting I found it completed and containing two hard set eggs. Wardlaw Ramsay and Oates found it breeding in Burma during August and September and its early breeding in Assam may have been due to the early breaking of the rains in that province and to the naturally wet and marshy nature of the country. The eleven eggs I have seen average 101·1 × 63·8 mm., maxima **106·8** × 63·8 and 103·6 × **68·0** mm.; minima **97·3** × 64·8 and 98·5 × **58·5** mm. I have seen no pure white eggs of this race. The birds from whom I took the eggs in Margherita made no defence of the nest and no protest beyond trumpeting as they flew away.

Habits. Quite similar in most respects to those of the preceding race but it is often found in marshes and plains of no great extent near forest and it seems to be a far more shy wild bird, very wary and very hard to approach close enough for a shot. I have seen them occasionally in Lakhimpur feeding in the rice fields in pairs but always on the lookout and always rising long before I could possibly

shoot at them. They seem to rise more easily than their Indian cousins, a few strides forward with spread wings and they were away and soon mounted two or three hundred feet into the air. Their high-flying propensities are no doubt due to their living in better wooded, more forested countries than the Indian birds, this teaching them to rise more quickly and to keep higher up than they do. Their beautiful trumpet call is that of the genus and is a fine sound when it rings out in the early dawn of a clear Indian Winter morning. The few I have seen were not noisy birds, but Oates says of the Pegu birds that their fine trumpet calls may be heard at all seasons.

(*To be continued*)

REVISION OF
THE FLORA OF THE BOMBAY PRESIDENCY

BY

E. BLATTER, S.J., PH.D., F.L.S.

PART VII

GRAMINEÆ

BY

E. BLATTER and C. McCANN

(*Continued from p.* 649 *of Volume XXXII*)

50. PSEUDECHINOLÆNA, Stapf in Prain Fl. Trop. Afr. ix, 494.

Annual. Culms very slender with a prostrate rooting base. Leaf-blades lanceolate, soft. Spikelets very irregularly armed or quite unarmed, obliquely ovoid, laterally compressed and mostly conspicuously gaping, falling entire from the pedicels, binate or more often subsolitary or solitary, secund on the flat or subtriquetrous slender rhachis of spiciform racemosely arranged racemes. Involucral glumes herbaceous, of about the same length and almost as long as the spikelet, or the lower distinctly shorter, heteromorphous. Lower more or less flat, 3-nerved, smooth or almost so; upper boat-shaped, gibbous downwards, 7-nerved, with longitudinal rows of more or less transparent spots between the nerves and with or without shorter or longer, stout, hooked hairs or bristles from the centre of the spots Lower floret male or barren, as long as the spikelet; glume oblong-lanceolate with a minutely truncate tip, laterally compressed, but rounded on the back, chartaceous, with membranous margins and a delicate hyaline area at the base, smooth, pale almost as long as the glume, more or less convolute, faintly 2-nerved. Upper floret hermaphrodite, shorter than the lower; glume broad-lanceolate to oblong, subacute, very convex on the back, chartaceous, faintly 5-nerved pale similar to the valve in texture, tightly clasped by it when mature. Lodicules 2, cuneate Stamens 3. Styles free at the base, capillary; stigmas plumose, subterminally exserted. Grain oblong in face-view, semi-obovate in profile, back very convex; scutellum elliptic, almost half the length of the grain; hilum subbasal, punctiform.

Species 1.—Tropics of the whole world.

The only species of this genus was originally described under *Echinolæna*. This genus, however, is exclusively American which, according to Stapf, differs from *Pseudechinolæna* in many ways, 'as in its densely packed spikes, the many-nerved lower glume, the "eglandular" always unarmed upper glume, the uniformly papery 5-nerved lower valve [lower floral glume] which is accompanied by a sharply 2-keeled flat valvule [pale], the basally appendaged fertile valve [upper floral glume] and the acutely auricled or toothed flaps of its valvule [pale], and finally the flatter grain which is marked with a panduriform line on the face extending through its full length and possesses a slender linear hilum.'

Pseudechinolæna polystachya, Stapf in Prain Fl. Trop. Afr. ix, 495 – *Echinolæna polystachya*, H. B. & K. Nov. Gen. *et* Sp. i, 119, vii, t 679; Kunth Enum. i, 172, Suppl. 127; Hitchcock Mex. Grass. in Contr. U. S. Nat Herb. xvii, 223; A. Chase in Proc. Biol. Soc. Wash. xxiv, 118.—*E. Trinii*, Moritzi Syst. Verz. Zoll 102 —*Lappago aliena*, Spreng. Neue Entdeck. iii, 15.—*Panicum uncinatum*, Raddi Agrost. Bras. 41; Trin. Gram. Panic. 240, and Sp Gram. Ic. t. 216; Kunth Enum. i, 172; Steud. Syn. Pl. Glum. i, 60; Hook. f. in F.B.I. vii, 58; Trim Handb. Fl. Ceyl v, 160.—*P glandulosum*, Nees ex Trin. Gram. Pan. 174, and Agrost. Bras. 128.—*P. nemorosum*, β Trin. l.c.—*P.*

heteranthum, Link Hort. Berol. i, 212, Kunth l.c. 92.—*P. echinatum*, Willd. ex Doell in Mart. Fl. Bras. II, ii, 193.—*P. polystachyum*, K. Schum. in Engl. Pfl. Ost.-Afr. C. 103 (*non aliorum*).

Description: Perennial. Culm about 60 cm long, of which about half is rising above ground, and the other half prostrate, giving off numerous short or long branches, growing into secondary culms, their bases often finely filiform, all many-noded and rooting from the nodes near the ground; erect or ascending portion above the last branch 5-8-noded with as many perfect leaves; internodes exserted, terete, glabrous. Leaf-blades lanceolate from a shortly contracted or rounded and usually slightly oblique base, acutely acuminate, from less than 12 mm. (lowest) to up to over 6 cm. by 4-12 mm., dark green, glabrous, with scattered or very fine stiff hairs above, finely and appressedly pubescent underneath, midrib very fine, whitish or straw-coloured, lateral nerves fine, numerous, crowded. Sheaths tight, terete, strongly striate, more or less appressedly hairy and ciliate along the margin or only ciliate. Ligules thin, membranous, rounded or truncate, ciliolate, under 2 mm. long. Inflorescence up to over 15 cm. long, with up to 6 or even 8 racemes, mostly much shorter and with fewer racemes, occasionally reduced to a solitary raceme; common axis subterete, almost smooth, glabrous, 0·5 mm. in diam.; racemes appressed to the common axis or obliquely spreading, the lowest up to 35 mm. long, sometimes quite short; rhachis filiform, triquetrous, minutely puberulous; pedicels filiform, angular, pruinosely scaberulous, lateral up to 2 mm. long, often much shorter. Spikelets often unequally developed, the lower of each raceme or the lower (secondary) of each pair often reduced in a varying degree, if perfect about 4 mm. long. Involucral glumes dull or brownish green; lower oblong- to ovate-lanceolate, acuminate, as long as the spikelet or shorter, glabrous or sparingly and minutely scaberulous, nerves stout; upper semi ovate in profile, acute with the tip laterally compressed, armature vary variable in the same raceme, from short asperities to sharply pointed hairs bent at a right angle near the base, then appressed and directed forwards, or short or long (to over 1 mm.), cylindric or stoutly subulate protruberances bearing terminally at a right angle a fine very sharp bristle pointing mostly forwards, outermost lateral nerves marginal. Lower floral glume pale, greenish only at the tip, very delicately scaberulous, hyaline basal area oblong, 1 mm. long; upper slightly over 2 mm. long, straw-coloured smooth, shining. Grain 1·6 by 0·6 mm., pale.

Locality: Kanara: Siddhapur, evergreen forest (Talbot 1081!).

51. Oplismenus, P. Beauv. Fl. Owar. ii, 14; Stapf in Prain Fl. Trop. Afr. ix, 630.

Species about fifteen, in the warmer parts of the world, but mostly tropical. We retain tne two species mentioned by Cooke ii, 926, 927.

1. **Oplismenus compositus,** P. Beauv. Agrost. (1812), 54; Roem. & Schult. Syst. ii, 484; Kunth Enum. i, 141; Aitchis. Cat. Panjab Pl. 161; Duthie Grass. N. W. Ind. 81; Hook. f. F.B.I., vii, 66; Cke. ii, 926; Haines Bot. Bihar & Orissa 999; Stapf in Prain Fl. Trop. Afr. ix, 634. For syn. see Hook. f. and Stapf ll. cc.

Description: Cke. l.c. A very variable plant.

Locality: Khandesh: Toranmal (McCann 9593!).—*Konkan:* At the foot of the Ghats under the shade of trees (Dalzell & Gibson); Bassein (Chibber 164!); Kenery Caves (McCann 9445!); Sion, woods (Blatter 9591!); Matheran, to Louisa Point (D'Almeida A244!, Woodrow); Thana (Lisboa).—*Deccan:* Igatpuri (McCann 4342!); Khandala, common in forests (McCann 5335!); Lonavla (Lisboa); Panchgani, Tiger path (Blatter & Hallberg B1253!).—*S. M. Country:* Bidi, shade of trees (Sedgwick & Bell 2962!); forests W. of Dharwar (Sedgwick & Bell 1853!); Castle Rock (Bhide!, McCann!); Londa (Woodrow!).—*Kanara:* Yellapore (Talbot 736!); Karwar (Talbot 1322!); Goond (Talbot 2204!); Amshi Ghat (Talbot 2192;); Kadgal (Woodrow).

Distribution: Throughout India, Ceylon, tropical and subtropical Asia. Australia and Polynesia.

2 **Oplismenus Burmanni,** P. Beauv. Agrost. (1812), 54; Roem. & Schult. Syst. II, 482; Kunth Rev. Gram. i, 44, and Enum. i, 139; Duthie Grass. N. W. Ind. 8., Ill. Indig. Fodd. Grass. t. 47, Fodd. Grass. N. Ind. 13; Hook.

f. F. B. I. vii, 68; Cke. ii, 927; Haines Bot. Bihar & Orissa 999; Stapf in Prain Fl. Trop. Afr. ix, 636.—For syn. see Hook. f. and Stapf 11. cc.

Description: Cke. l.c.

Locality: Gujarat: Surat, shady places (Sedgwick 314!).—*Konkan*: Versova (McCann 4313!); Alibag, sandy shore, on the roots of coconut tree (Ezekiel!); Bombay Isl. (McCann!); Parel (Herb. Dehra Dun!, Woodrow).—*Deccan*: Chakan (Gammie!); Khandala, very common, forming carpets under trees (McCann 9592!); Lonavla (McCann 3898!); Igatpuri (McCann!); Panchgani (Woodrow).—*S.M. Country*: S. W. of Dharwar (Sedgwick & Bell 4438!); Dharwar, shade of trees (Sedgwick 1837!); Londa (Gammie 15826!); Castle Rock (Gammie 15696!).—*Kanara:* Halyal (Talbot 2085!); Karwar (Talbot 1295!).

Distribution: Widely distributed throughout the tropics of both hemispheres.

52. Panicum, Linn. Stapf in Prain Fl. Trop. Afr. IX, 638.

Annual or perennial grasses, rarely suffrutescent, of various habit and size. Leaves mostly linear to linear-lanceolate, but also ovate or filiform to subulate. Ligules usually reduced to a ciliate rim or a fringe of hairs, rarely a distinct membrane or 0. Panicles usually much divided and at least temporarily open. Spikelets usually loosely scattered, glabrous or hairy, lanceolate to oblong, elliptic or orbicular in outline, symmetrical in profile, rarely somewhat oblique, falling entire or almost so from the often elongated pedicels of a compound or decompound panicle, without a definite orientation towards the axis. Involucral glumes more or less herbaceous-membranous, lower usually shorter than the upper, often very much so, rarely equalling it, usually with 1 or more nerves, or if very small, nerveless; upper as long as the spikelet, rounded on the back, 5-9-nerved Lower floral glume very similar to the upper involucral glume and equally rounded and curved on the back, 5-9-, rarely 3- or 11-nerved, male or neuter, pale thinly membranous to subhyaline, subequal to the lower floral glume or more or less reduced, rarely suppressed. Upper floral glume subcoriaceous to coriaceous with firm margins, obtuse to subacute, emucronate, faintly nerved, hermaphrodite, pale subequal to the glume and of similar substance, tightly embraced by the more or less involute margins of the glume. Lodicules 2, broadly cuneate. Stamens 3. Styles distinct; stigmas laterally exserted near the tip of the floret. Grain tightly enclosed by the hardened valve and valvule, dorsally compressed, biconvex to almost plano-convex; scutellum elliptic to ovate-elliptic, about half as long as the grain; hilum subbasal, punctiform

Species about 400. In the tropical and subtropical regions of both hemispheres, few in the warm-temperate regions.

Cooke mentions 20 indigenous and 4 cultivated species.

Of the 24 species we have put *Panicum flavidum*, Retz., *P. punctatum*, Burm., and *P. fluitans* under *Paspalidium*.

Panicum stagninum, Retz. and *P. colonum*, Linn. have been transferred to *Echinochloa*.

Panicum Isachne, Roth, *P. ramosum*, Linn. and *P. muticum*. Forsk. belong to *Brachiaria*.

Panicum prostratum, Lamk, *P. setigerum*, Retz. and *P. javanicum*, Poir. have been described under *Urochloa*.

Panicum interruptum, Willd. and *P. myosuroides* will be dealt with under *Sacciolepis*.

Panicum patens, Linn. will be transferred to *Cyrtococcum*.

New to the Presidency are *P psilopodium*, Trin. and *P. auritum*, Presl.

A. Lower involucral glume as long as the lower floral glume or nearly so ... ... 1. *P. turgidum*.
B. Lower involucral glume shorter than the lower floral glume
  I. Annuals
    1. Leaves less than 12 mm. broad
      a. Panicle about 35 cm. long ... ... 2. *P. obscurans*.
      b. Panicle not more than 25 cm. long
        aa. Spikelets gaping ... ... 3. *P. trypheron*.
        bb. Spikelets not gaping ... ... 4. *P. psilopodium*.

2. Leaves more than 12 mm. broad
   a. Spikelets 4·5-5 mm. long ... ... 5. *P. miliaceum.*
   b. Spikelets 2-3·2 mm. long ... ... 6. *P. miliare.*

II. Perennials
1. Lower involucral glumes very minute, one or rarely both often obsolete .. 7. *P. subeglume.*
2. Lower involucral glumes distinctly evident
   a. Culms up to 3 m. high ... ... 8. *P. maximum.*
   b. Culms less than 1·7 m. high
      aa. Culms not more than 90 cm. high... 9. *P. paludosum.*
      bb. Culms more than 90 cm. high
         + Spikelets laxly clustered on the branches... ... ... 10. *P. antidotale.*
         + + Spikelets solitary ... ... 11. *P. montanum.*
         + + + Spikelets fascicled, subsecund, sessile or shortly pedicelled ... 12. *P. auritum.*

1. **Panicum turgidum**, Forsk. Fl. Aegypt.—Arab. (1775), 18; Del. Fl. Egypte 19, t. 9, fig. 2; Trin. Diss. Gram. Pan. 189, Gram. Icon. & Descr. ii 227, Pan. Gen. 221, and in Mém. Acad. Pétersb. sér. vi, iii, 307; Kunth Enum. i, 97; Steud. Syn. Pl. Glum. i, 88; Boiss. Fl. Or. v, 441; Duthie Fodd. Grass. N. Ind. 13; Balf. f. Bot. Socotra 310; Hook. f. F.B.I. vii, 44; Stapf in Kew Bull. (1907), 214; Muschler. Man. Fl. Egypt i, 57; Cke. ii, 935; Stapf in Prain Fl. Trop. Afr. ix, 706.—*P. nubicum*, Fig. & De Not. in Mem. Ac. Torin. ser. 2, xiv, t. 21, fig. 1-12.

Description : Cke. l.c.

Locality : Sind : (Duthie *teste* Cooke); Sehwan, sand hills (Bhide!).—*Gujarat :* Rajkot, Kathiawar (Woodrow *teste* Cooke).

Distribution : Tropical Africa, Egypt, Cyprus, S. Palestine, Arabia, Socotra, S. Persia, Baluchistan, Sind, Gujarat.

Uses : An excellent fodder for camels.

2. **Panicum obscurans**, Woodr. in Journ. Bom. Nat. Hist. Soc., xiii (1901), 434; Cke. ii, 935.—*Isachne obscurans*, Woodr. in Gard Chron. 23, ser. 3 (1898), 161.

Description : Cke. l.c.

According to Woodrow the whole inflorescence breaks off and is driven about by the wind.

Stapf says that the tropical African *Panicum hippothrix*, K. Schum. is very similar and perhaps identical with *P. obscurans*, but he adds that the blades of the latter are much wider, measuring up to 14 mm. and that the panicle 'is perhaps on the whole more open with slightly larger spikelets.' (In Prain Fl. Trop. Afr. ix, 699.) These are scarcely differences to justify specific distinction, but as we have not seen the African plant, we do not venture to decide the point. If the identity between the two species should be established, Woodrow's specific name, being of a later date by four years, will have to cede to *P. hippothrix.*

Locality : Deccan : Mangiri Farm (Herb. Econ. Bot. Poona!); Jeur near Sholapur (Woodrow).

Distribution : Endemic.

3. **Panicum trypheron**, Schult. Mantiss. ii (1824), 244; Hook. f. in F.B.I. vii, 47; Prain Beng. Pl. 1176; Cke. ii, 936; Haines in Bot. Bihar & Orissa 995.—*P. miliare*, Wall. Cat. No. 8712 (*partim*) E.—*P. mucronatum*, Heyne in Wall. Cat. No. 8717 (*partim*).—*P. Neesianum*, Wight & Arn. ex Steud. Syn. Gram. 74.—*P. Roxburghii*, Spreng. Syst. i, 320; Kunth Enum. Pl. i, 126; Steud. l.c. 98.—*P. tenellum*, Roxb. Fl. Ind. i, 306; Duthie Grass. N. W. Ind. 7.

Stapf in Prain Fl. Trop. Afr. ix, 712 has separated *P. porphyrrhizos*, Steud. from *P. trypheron*, Schult, as understood by Hook. f. in F.B.I. l.c., and with it all the material covered by the following synonyms: *P. confine*, Hochst. ex Steud. Syn. Pl. Glum. i, 72.—*P. jumentorum*, A. Rich. Tent. Fl. Abyss. ii, 373 (*non* Jacq.).—*P. trypheron*, therefore, does not occur in tropical Africa.

Description : Cke. l.c.

Locality : Gujarat : On the Idar Frontier, Prantij Taluka, sandy waste (Sedgwick!).—*Konkan :* Malabar Hill (Lisboa *teste* Cooke).—*Deccan :* Poona

(Woodrow *teste* Cooke) ; Jeur (Woodrow *teste* Cooke) ; Malhargad (Woodrow *teste* Cooke).—*S. M. Country:* Dharwar (Garade !) ; Dharwar, on pastures and dry hills (Sedgwick 6144 !).

Distribution : Punjab, Bengal, W. Peninsula, Ceylon, China, Borneo.

4. **Panicum psilopodium**, Trin. Gram. Panic. 217 ; Kunth Enum. Pl. i, 100 ; Steud. Syn. Gram. 83 ; Aitchis. Cat. Panjab Pl. 161 ; Duthie Grass. N.W. Ind. 6, Field and Gard. Crops i, t. 23, Fodd. Grass. N. Ind. 10 (*in nota*) ; Hook. f. F.B.I. vii, 46 ; Saxton & Sedgwick, Plants of N. Gujarat in Rec. Bot. Surv. Ind. vi (1918), 312 ; Haines in Bot. Bihar & Orissa 993.

Description : An annual, tufted grass. Culms erect or quickly ascending, 30–60 cm. high, rather slender, simple or branched, usually leafy up to the panicle. Leaves rather broadly linear, acute or somewhat acuminate, 7–30 cm. by 4-8 mm. glabrous or with few short spreading hairs towards the base, rarely thinly hairy all over. Sheaths often with spreading hairs which leave minute raised dots after falling, more usually glabrous, loose, striate. Ligule a narrow row of hairs. Panicle spreading, 5–20 cm. long, with very capillary branches and slender pedicels which are often 10 mm. long. Spikelets 2–3 mm. long, geminate, narrowly elliptic, with abruptly acute tip. Lower involucral glume very broadly ovate-acute, about $\frac{1}{3}$ the spikelet, base amplexicaul but not overlapping itself in front, 5-nerved. Upper involucral glume oblong-ovate, as long as spikelet, minutely cuspidate, 9- (11-) nerved. Lower floral glume similar, with delicate, oblong, margined pale. Upper narrow-ellipsoid, acute, very smooth and polished as is its pale.

Locality : Gujarat : Ahmedabad and elsewhere in shady wet places in the monsoon (Saxton & Sedgwick).

Distribution : India, Burma, Malacca, Ceylon.

*5. **Panicum miliaceum**, Linn. Sp. Pl. (1753), 58; Forsk. Fl. Aegypt.—Arab. civ ; Host. Gram. Austr. ii, 16, t. 20 ; Kunth Enum. i, 104, Suppl. 81 ; Trin. Pan. Gen. 194, Sp. Gram. Ic. t. 221 ; Reichb. Ic. Fl. Germ. vii, t. 82 ; Steud. Syn. Pl. Glum. i, 77 ; Duthie Grass. N. W. Ind. 5, Field and Gard. Crops t. 23, Fodd. Grass. N. Ind. 9 ; Hook. f. F.B.I. vii, 45 ; Watt. Dict. Econ. Prod. Ind. vi, 12 ; Cke. ii, 939 ; Stapf in Prain Fl. Trop. Afr. ix, 696.—*P. asperrimum*, Fisch. Cat. Hort. Govenk. ex Jacq. Eclog. Gram. 46, t. 31 ; Nees Agrost. Bras. 199.—*P. Milium*, Pers. Syn i. 83.—*Milium esculentum*, Mœnch Meth. 203.—*M. Panicum*, Mill. Gard. Dict. ed. viii, no. 1.

Vern. Names: Common Millet ; cheno (Guj.) ; vari (Decc.) ; gajro (Panch Mahals) ; sava (Mar.) ; chinee (Sind).

Description : A tufted annual, 0·6—1·2 m. high. Stems erect or geniculately ascending, terete, stout or slender, 4–5-noded, simple or sparingly branched, more or less softly hirsute below the nodes, the uppermost internode usually quite glabrous. Leaf-blades linear from an equally wide or slightly contracted and rounded base, long-tapering to a slender point, 15 to over 30 cm. by 6–20 mm., flat, flexuous, usually glabrous except for the often ciliate lower margins and hispidulous dorsal midrib, rarely sparsely hairy all over, hairs long and fine, midrib somewhat stout and prominent below in large leaves, primary lateral nerves 3-6 on each side, very slender. Sheaths terete, somewhat loose or the upper tight, closely striate, spreadingly hirsute with tubercle-based hairs, pubescent or loosely bearded at the nodes, longer or slightly shorter than the internodes. Ligule a narrow ciliate rim. Panicles contracted and rather dense or open, narrowly oblong, nodding, often with their base permanently enclosed in the uppermost sheath or only shortly exserted, up to 30 cm. long in subspontaneous specimens usually scantier, looser and at length more open, divided up to the fourth or in cultivated specimens the fifth degree, all the divisions filiform, angular and scabrid ; primary axis slender or somewhat stout below, subterete, striate or grooved and smooth towards the base ; primary branches more or less approximate below, more distant upwards, often much divided from low down ; branchlets relatively long, the lower divided again in the same manner or like the remainder from much higher up with spikelets in small loose racemes of 2 (rarely 3) towards the summit ; pedicels hardly thickened upwards, with truncate tips, the lateral from less than 2–6 mm. long. Spikelets ovate-oblong to ovate-lanceolate, apiculate-acuminate, turgid, 4·5–5 mm. long, glabrous, green or brownish green. Involucral glumes persistent, unequal, strongly and prominently nerved ; lower broad-ovate, acute,

from $\frac{1}{2}$–$\frac{2}{3}$ the length of the lower floret, 5-nerved, upper corresponding in size and outline to the spikelet, broadly rounded on the back, 11-nerved, tip contracted, apiculate to shortly rostrate. Lower floral glume barren, very like the lower involucral glume, pale ovate to ovate-oblong, truncate or emarginate, up to about $\frac{2}{3}$ the length of the glume. Upper floret hermophrodite, elliptic-oblong in outline, subacute, very convex on the back, up to over 3 by 2 mm., variously coloured (white, yellow, red, brown or black), very smooth and polished, glume and pale crustaceous. Grain white.

Locality : Cultivated in many parts of the Presidency, chiefly in Gujarat and on the Ghats.

Distribution : Supposed to have originated in India. But see DeCandolle, Origin of Cultivated Plants, p. 376, London 1909.

Uses : Cultivated for its grain and as a good fodder.

*6. **Panicum miliare,** Lamk. Ill. Gen. i (1791), 173; Roxb. Fl. Ind. i, 309; Kunth Enum. Pl. i, 104; Aitchis. Cat. Panjab. Pl. 159; Duthie Grass. N. W. Ind. 5, Field and Gard. Crops 7, t. 26, Indig. Fodd. Grass. t. 46, Fodd. Grass. N. Ind. 10; Hook. f. in F.B.I. vii, 46; Cke. ii, 939 (*partim*); Haines in Bot. Bihar & Orissa 993.

Description : An annual grass. Culms 30–90 cm. high, rather slender, erect or base geniculate, simple or branched, usually leafy up to the panicle. Leaves linear, 15–60 cm. by 12–25 mm., gradually tapering from a broad base, glabrous or finely hairy, sheaths glabrous, rarely hirsute with tubercle-based hairs. Panicles very compound, contracted or thyrsiform, and often nodding, 10–25 cm. long (without the subsidiary axillary panicles which are often developed). Spikelets glabrous, rather flattened, suddenly acute or slightly cuspidate, 2–3·2 mm. long, mostly paired on unequal pedicels, but often solitary at the ends of the branchlets, lanceolate in flower, elliptic or broadly elliptic in fruit. Lower involucral glume very broadly ovate, subtruncate, then suddenly acute, or scarcely acute, about $\frac{1}{3}$ the spikelet, white, membranous, 3–5-nerved, nerves arching and anastomosing. Upper involucral glume herbaceous, ovate-lanceolate, 11-13-nerved. Lower floral glume 9-nerved, neuter, pale as long as its glume. Upper floral glume narrow-elliptic or elliptic-oblong to broadly ovate, acute, shining, white or pale brown, or dark brown, often 3-5-streaked dorsally.

Locality : Cultivated occasionally in some parts of the Presidency.

Note.—*P. miliare* is in all probability a cultivated form of *P. psilopodium.* It is not always easy to distinguish between the two. Hooker already felt this difficulty. 'If I remember aright,' he says, '*P. miliare* was conjectured by Munro to be a cultivated form of *P. psilopodium*; and except in the greater size, more contracted panicle, rather larger spikelets and usually shorter pedicels of *P. miliare* I failed to find characters whereby to separate them, and these are not very reliable. In its common state the grain of *miliare* is broader than in any form of *psilopodium* and much darker coloured.' (F.B.I. vii, 46). Duthie was unable to distinguish *P. miliare* from *P. psilopodium* (Fodd Grass, N. Ind. 10). Stapf, however, is inclined to think that they are separable. In his opinion the true *P. psilopodium* has nearly always glabrous leaves, smaller spikelets and a shorter lower involucral glume. Prain in his Bengal Plants gives as the characters of *P. miliare* : 'Leaves hairy; cultivated', and of *P. psilopodium:* 'Leaves glabrous; wild.' But he has nevertheless, as Haines points out 'named most of the glabrous-leaved forms in the Calcutta Herb. as *miliare*, and I have myself noticed whole crops with glabrous leaves, whereas I have collected *psilopodium* with hairy leaves.'

The same author, after discussing the various statements, sums up his own observations: 'Although absolutely the leaves of *miliare* are often broader than in *psilopodium*, yet they are relatively narrower and much more alternate. Moreover the cultivated *miliare* and its feral forms always appear to have more or less contracted panicles in contrast to the shorter, always quickly effuse, panicle of *psilopodium*. The grain of *miliare* is, as would be expected, rather larger, being ·08-·1 in. long as compared with ·07 in. long in *psilopodium*.'

7. **Panicum subeglume,** Trin. in Mém. Acad. Pétersb. sér. 6, iii, pt. 2 (1835), 292; Steud. Syn. Gram. 82; Hook. f. F.B.I. vii, 51; Cke. ii, 936.—*P. arcuatum*, Br. ex Nees in Wight Cat. no. 1639 (*non* Br. Prodr.).—*P. Brownianum*, Wight & Arn. ex Steud. l.c. 98.—*P. Torreyanum*, Wight & Arn. ex Steud. Nom. ed. 2, ii, 264.—*Milium capillare*, Roth. Nov. Sp. 39; Kunth

Enum. Pl. i, 67.—*M. tomentosum*, Koen. ex Rottl. in Ges. Naturf. Fr. Neue Schr. iv (1803), 220; Steud. Syn. Gram. 34; Kunth l.c. 66.

Description: Cke. l.c.

Locality: S. M. Country: Badami (Woodrow *teste* Cooke; Bhide!).

Distribution: W. Peninsula.

*8. **Panicum maximum,** Jacq. Ic. i, 2, t. 13; Collect. i, 76; Trin. Pan. Gen. 180, and in Mém. Acad. Pétersb. 6 sér. iii, 268; Nees Fl. Afr. Austr 36; Steud. Syn. Pl. Glum. i, 72; Griseb. Fl. Brit. West Ind. 549: Doell in Mart. Fl. Bras. ii, ii, 202: Aitchis. Cat. Panjab Pl. 159; Baker Fl. Maurit. 436; Boiss. Fl. Or. v, 439; Hook. f. F.B.I. vii, 49; Trim. Fl. Ceyl. v, 153; Stapf in Dyer Fl. Cap. vii, 404; Cke. ii, 939; Haines in Bot. Bihar & Orissa 995; Stapf in Prain Fl. Trop. Afr. ix, 655.—*P. maximum* var. *hirsutissimum*, Oliv. in Trans. Linn. Soc. xxix, Bot. 171.—*P. maximum* var. *obtusissimum*, Stapf in Cheval. Sudania 161, 163.—*P. polygamum*, Sw. Prodr. Ind. Occ. 24.—*P. laeve*, Lam. Ill. i, 172.—*P. jumentorum*, Pers. Syn. i, ·3; H.B. & K. Nov. Gen. & Sp. i, 104; Duthie Grass. N. W. Ind. 5, Fodd. Grass N. Ind. 9.—*P. altissimum*, Brouss. Elench. Hort. Monsp. (1805), 42 (*non* Meyer); Dalz. & Gibs. Bomb. Fl. Suppl. 98.—*P. trichocondylum*, Steud. Syn. Pl. Glum. i, 74.—*P. pamplemoussense*, Steud. l.c 71.—*P. hirsutissimum*, Steud. l.c. 72.—*P. giganteum*, Mez. in Engl. Jahrb. xxiv, 143.

Vern. Name: Guinea Grass.

Description: A perennial, densely tufted grass, up to 3 m. high. Culms erect or geniculate-suberect, usually stout, 3-4 noded, simple or sparingly branched with the branches erect, terete or compressed below, usually quite glabrous and smooth, more rarely more or less hirsute and rough from the tubercular hair-bases. Leaves glabrous or more or less softly hairy or coarsely hirsute with tubercle-based hairs. Sheaths rather firm, the lower compressed, the others terete and tight, often bearded at the mouth and usually so at the nodes, rarely the nodes quite glabrous. Ligule membranous, very short, ciliolate usually with dense hairs from behind it. Blades linear from an equally wide or very gradually narrowed and shortly contracted base, long-tapering to a fine point, 10–60 cm. by 4–18 or even 25 mm., flat, margins scaberulous to spinulously scabrid, midrib prominent below, whitish and shallowly channelled above, primary nerves up to 9 on each side. Panicle erect or nodding, contracted or open, from 10 to over 45 cm. long, glabrous or more often villosulous at the lower nodes and motile branch bases, divided to the 4th or 5th degree, all the divisions filiform to capillary, often more of less wavy, angular and scabrid or the larger smooth downwards; primary axis comparatively slender, smooth, terete and often fluted below, scaberulous upwards; lower primary branches whorled, suberect or spreading, up to 30 cm. long, mostly remotely divided from 2·5–7·5 cm. above the base, their lower branchlets often up to 7·5 cm. long, flexuous and remotely divided or like the rest rather short and contracted; penultimate divisions usually closely 2–3-spiculate with the lateral pedicels shorter than the clustered spikelets, more rarely loose to very loose with the pedicels several times longer, all the pedicels very fine with small subcupular tips. Spikelets oblong, subobtuse to acute, somewhat turgid, broadly rounded on the back, 3–4·5 or sometimes 4 mm. long, light green or tinged with purple, glabrous or rarely more or less densely pubescent. Involucral glumes dissimilar, faintly nerved. Lower rounded or shortly acute or minutely apiculate, about $\frac{1}{3}$ to $\frac{1}{4}$ the length of the spikelet, hyaline, 3-1-nerved or almost nerveless. Upper corresponding in shape and size to the spikelet, membranous, 5-nerved. Lower floral glume male, like the upper involucral glume, 7-nerved, pale slightly shorter, oblong, obtuse. Upper floret hermaphrodite, oblong, shortly acute up to almost 3 mm. long, whitish, glume and pale thinly crustaceous, finely transversely rugose except on the flexures. Anthers 1–1 5 mm. long. Grain over 1 mm. long.

Locality: Widely cultivated, chiefly in Gujarat and Sind.

Distribution: Indigenous in tropical and S. Africa, Madagascar, the Mascarenes and in Yemem. Introduced into India and America.

Uses: An excellent fodder grass.

9. **Panicum paludosum,** Roxb. Fl. Ind. i (1832), 307 (*non* Nees); Wall. Cat. no. 8711; Griff. Notul. 37, Ic. Pl. Asiat. t. 139. f. 127; Duthie Fodd. Grass. N. Ind. 11.—*P. proliferum*, Hook. f. in F.B.I. vii, 50 (*non* Lam.)—*P. proliferum*,

var. *paludosum,* Cooke in Fl. Bomb. ii, 937 (*non* Stapf).—*P. proliferum* Haines in Bot. Bihar & Orissa 995 (*non* Lam.)—*P. proliferum,* Prain in Beng. Plants 1176 (*non* Lam.).—*P. decompositum* var. *paludosum,* Trim. Cat. Ceyl. Pl. 105.

The explanation for the above synonymy is contained in a note given by Stapf (in Prain Fl. Trop. Afr. ix, 719) to justify his new species *Panicum longijubatum,* Stapf of tropical Africa which, on a previous occasion, he had described as var. *longijubatum* of *P. proliferum* (in Dyer Fl. Cap. vii, 406).

'The *P. proliferum* of authors covers a number of allied yet clearly distinct species. The name is Lamarck's, but since Hitchcock (in Contrib. U. S. Nat. Herb. xii. 147) has shown that his plant so named is identical with *P. miliare,* Lam., *P. proliferum* becomes a synonym unconnected with any of the forms so far referred to it. Of these, one, namely Hooker's *P. proliferum* (Fl. Brit. Ind. vii. 50), is identical with Roxburgh's *P. paludosum* (Roxb. Fl., Ind. ed. Carey, i. 307), another, a native of America, is *P. dichotomiflorum,* Michx. (Fl. Bor. Am. i. 48). Both appear to me sufficiently distinct from the African plant described above; *P. paludosum* mainly by its conspicuously larger and more finely acuminate spikelets; *P. dichotomiflorum* by its pronounced branching habit and the smaller number of nerves of the upper glume (mostly 7) and lower valve (5-7, mostly 5).'

Description : Cke. l.c.

Locality : Konkan : Byculla (McCann A140!); Sewri (McCann 3641!); Salsette (Lisboa *teste* Cooke).—*Deccan :* Khandala (McCann 5310!); Poona (Lisboa *teste* Cooke); Lonavla (Lisboa *teste* Cooke).—*S. M. Country :* Devarayi (Sedgwick 4118!).—*Kanara :* Gersoppa Falls, on rocks in river bed, common (Hallberg & McCann A139!); Karwar (Hallberg & McCann A124!).

Distribution : India, Ceylon. (It certainly does not occur in tropical and S. Africa, but whether it extends eastwards beyond India we are not able to say).

10. **Panicum antidotale,** Retz. Obs. fasc. 4 (1786), 17; Hook f. in F.B.I. vii, 52; Cke. ii, 937; Blatter Fl. Aden 372.—For other references and synonyms see Hook. f. l.c.

Description · Cke. l.c.

Locality : Sind : (Stocks 659 *teste* Cooke); Karachi to Landi (Burns!); Laki (Bhide!); Sukkur (Woodrow *teste* Cooke); Clifton, near Karachi (Sabnis B797!); Umerkot, sand dunes (Sabnis B1080!); Mirpurkhas (Bhide!); Mirpurkhas, in fallow fields (Sabnis B1208!); Jamesabad, in fields (Sabnis B1154!); Sanghar (Sabnis B769!); Gharo (Blatter & McCann D506!, D608!). —*Gujarat :* Bhuj, Rhodi Maka, Cutch (Blatter 3751!); Sumrasar, Cutch (Blatter 3760!); Kathiawar (Woodrow *teste* Cooke).—*S. M. Country:* Dharwar (Garade!); Londa (Woodrow *teste* Cooke).

Distribution: Arabia, Afghanistan, Punjab, Upper Gangetic Plain, W. Peninsula, Ceylon, Australia.

11. **Panicum montanum,** Roxb. Fl. Ind. i (1832), 313 (*excl. descr. gluma sup. florali*); Kunth Enum. Pl. 126; Benth. Fl. Hongk. 412; Hook. f. F. B. I. vii, 53; Cke. ii, 938; Haines Bot. Bihar & Orissa, 996.—*P. courtallense,* Nees & Arn. ex Wight Cat. no. 2342; Steud. Syn. Gram. 83.—*P euchroum,* Steud. l.c. 98.

Description: Cke. l.c.

Locality: Konkan : Pen, hills (Bhide!); Kenery Caves (McCann A134!, A136!).—*Deccan :* Lohagad, half way up (McCann A137!); Khandala (McCann A136!); Lonavla (Garade!).—*S. M. Country :* Castle Rock, on hill behind station (Bhide!).—*Kanara :* Dandeli (Talbot 2243!); Kala Nuddie (Herb. Econ. Bot. Poona!); Karwar, hillside in shade of trees (Hallberg & McCann A135!, Talbot!); Sumpkhund (Hallberg & McCann 9935!).

Distribution : Hotter hilly parts of India, Ceylon, Penang, Malaya, China, Philippines.

12. **Panicum auritum,** Presl ex Nees Agrost. Bras. 176; Rel. Haenk. i, 305; Trin. Pan. Gen. 176; Kunth Enum. Pl. i, 113; Steud. Syn. Gram. 70; Baker Fl. Maurit. 437; Miq. Fl. Ind. Bat iii, 456; Hook. f. F.B.I. vii, 40; Haines Bot. Bihar & Orissa. 996.—*P. insulicola,* Steud. l. c. 78.—*P. javanum,* Nees

and Bühse in Miq. Pl. Jungh. 376 ; Miq. Fl. Ind. Bat. l.c. 453.—*P. patens*, Bojer Hort. Maurit. ex Baker l.c.

Description : A perennial, tall, erect grass. Culm 0·9–1·6 m. high, soft. Leaves linear-lanceolate, broadly cordate at base, 20–35 cm. by 24–30 mm. glabrous or sparsely hairy beneath. Sheath glabrous or sparsely hairy with villous mouth. Ligule very short. Panicle long contracted or more or less effuse, 20–45 cm. long, fastigiately branched, branches erect, 5-12 cm. long, branchlets and fascicles of spikelets subsecund. Spikelets green, glabrous, 1·7–2·5 mm., sessile or shortly pedicelled, strongly nerved, subacute. Lower involucral glume broadly ovate, $\frac{1}{3}$ – $\frac{1}{2}$ the length of the lower floral, obtuse or acute, nerves 3–5 arching, upper involucral and lower floral subequal, ovate-oblong, acute or acuminate, 5-nerved, pale of lower floral glume small, neuter. Upper floral glume as long as the lower, lanceolate-acuminate, smooth, white, thinly coriaceous.

Locality : S. M. Country : Castle Rock (Gammie 15717 !).

Distribution : India, Ceylon, Malay Peninsula, Malaya, China.

53. Hymenachne, Beauv. Agrost. (1812), 48, t. 10, f. 8.

Rather stout grasses. Leaves broadly linear. Panicles thyrsoid, branches erect, appressed with spiciform branchlets and very numerous crowded narrowly lanceolate acuminate secund spikelets, articulate on their minute pedicels. Lower involucral glume cuspidate, keeled, membranous, shortest, upper with sheathing amplexicaul base on the long internode of the rhachilla between it and the lower floral glume, prominently 3-nerved, cuspidate or awned. Lower floral glume longest, lanceolate-acuminate, passing gradually into the awn, with three strong nerves meeting in the base of the awn and two lateral weaker ones empty; upper longer than upper involucral glume, oblong, membranous in flower scarcely hardened in fruit, smooth, faintly 2-nerved, embracing the pale except at the tip, pale similar and as long. Lodicules minute. Stamens 3. Styles free.

This genus is not represented in Cooke. The following species is described in the F.B.I. under *Panicum myurus*, H.B. & K.

1. **Hymenachne myuros,** Beauv. Agrost. (1812), 49, t. 10, fig. 8 (*excl. syn.* Lam.) , Nees Agrost. Bras. 275 ; Griseb. Fl. Brit. West Ind. 553 (*excl. syn.*) ; Steud. Syn. Gram. 78 ; Haines Bot. Bihar & Orissa 991.—*Panicum myurus*,, H.B. & K. Nov. Gen. & Sp. i, 98 (*excl. syn.* Lam.) ; Kunth Rev. Gram. i. 33. Enum. Pl. i, 86, Suppl. 65 ; Duthie Fodd. Grass. N. Ind. 10 (*excl syn.*) ; Benth. Fl. Austral. vii, 480 (*excl. syn. interruptum*) (*Excl. in omnibus syn.* Lam., Rudge, Richard, Trin.) ; Hook. f. in F.B.I. vii, 39.—*P. acutiglumum*, Steud. Syn. Gram. 66.—*P. auritum*, Hassk. Pl. Rar. Jav. 22 (*non* Presl.)—*P. Hasskarlii*, Steud. in Zoll. Syst. Verz. 54, Syn. Gram. 70 ; Miq. Fl. Ind. Bat. iii. 456.—*P. myurum*, Meyer Fl. Esseg. 50 (*excl. syn.* Lam. & Rudge.). —*P. mangaloricum*, Steud. l. c. 78.—*P. serrulatum*, Roxb. Fl. Ind. i. 307 ; Kunth. Enum. Pl. i, 126.—*Agrostis monostachys*, Poir. Encycl. Suppl. i, 256, ex Kunth l.c.

Description : Culm stout, tall, 0·6–1·8 m. high, spongy below, rooting at the nodes of the prostrate base, erect, leafy. Leaves 20–50 cm. by 18–25 mm. flat, tapering from a broad cordate base to a fine point, margin serrulate ; sheath smooth, glabrous or ciliate ; ligule very short, rounded, hyaline. Panicle very dense, narrow, very compound with closely appressed branches, 15–30 cm. long, rarely 25 mm. diam., often interrupted, sometimes quite cylindric. Spikelets variously grouped, shortly and unequally pedicelled, secund on the erect branches of the panicle, 4–6 mm. long, narrowly lanceolate, pale green. Lower involucral glume $\frac{1}{3}$ of the lower floral glume, narrow from an amplexicaul base, aristulate, hispidulous on keel and cusp ; upper narrowly lanceolate, subaristate, hispidulous, 3-nerved. Lower floral glume much longer than upper involucral glume, narrowly lanceolate, gradually tapering into the awn as long as spikelet, strongly 3-nerved, hispidulous on nerves, pale imperfect or 0 ; upper small, thin, narrow, finely acuminate, almost embraced by the lower, shorter than the upper involucral glume, enclosing its pale on the edges. Styles distinct.

Locality : S. M. Country : Tadas, tanks, elevation 2,000 ft., rainfall 35 inches (Sedgwick & Bell 4917 !).

Distribution : Tropical Asia, Australia and America.

54. CYRTOCOCCUM, Stapf in Prain Fl. Trop. Afr. ix, 745.

Perennial. Culms weak, rising from a decumbent or creeping and rooting base. Leaf-blades flat, linear-lanceolate or almost linear. Ligules membranous, short. Spikelets on long to very long and capillary or short pedicels, widely scattered or approximate, obliquely obovate to semi-obovate, laterally much compressed, falling entire from the pedicels of very loose and open or contracted and dense panicles. Involucral glume thinly membranous, unequal to subequal, 3–5-nerved. Lower floret barren with or without a pale, glume similar to the upper involucral glume, pale, if present, narrow, 2-nerved. Upper floret about as long as or almost as long as the lower, hermaphrodite, glume narrowly boat-shaped, papery to subcrustaceous with firm very narrowly involute margins, obsoletely 5-nerved; pale subequal to the glume, with a narrow convex back, of the same substance as the valve, with fine keels and thin flaps. Lodicules two, minute, broadly cuneate. Stamens three. Styles distinct; stigmas sublaterally exserted high up. Grain not known.

Species 6 or 7. Tropical Africa, Indo-Malaya.

None of the species here described were mentioned by Cooke. Hook. f. in. F.B 1. has them under *Panicum*, sect. *Gibbosæ*.

I. Spikelets shortly pedicelled
 1. Leaves 2·5–5 cm. long ... ... 1. *C. trigonum.*
 2. Leaves 5–15 cm. long ... ... 2. *C. pilipes.*
II. Spikelets on capillary pedicels which are much longer than the spikelets ... ... 3. *C. patens.*

1. **Cyrtococcum trigonum,** A. Camus in Bull. Mus. Hist. Nat. 27 (1921), 118.—*Panicum trigonum*, Retz. Obs. iii, 9 (*excl. syn.* Burm.); Kunth Enum. Pl. i, 116; Nees Agrost. Bras. 206; Roxb. Fl. Ind. i, 305; Hook. f. F.B.I. VII, 56.—*P. difforme*, Roth. Nov. Sp. 52.—*P. radicans*, Bühse in Miq. Pl. Jungh, 375; Miq. Fl. Ind. Bat. iii, 453 (*non* Retz.).—*P. gibbum*, Steud. Syn. Pl. Glum. 87.

Description: Perennial. Culms decumbent, branching, interlaced below; branches erect. Leaves 2·5–5 cm. long, linear-lanceolate, glabrous or laxly hairy. Sheath glabrous or margin ciliate. Ligule rounded. Panicle 25–35 mm. long, contracted, rhachis and short, suberect branches glabrous. Spikelets 1·5 mm. long, very shortly pedicelled, hispidulous. Lower involucral glume about ½ the length of the lower floral glume, obtuse or acute, 3-nerved, pale brown; upper pale brown. Lower floral glume 5-nerved, pale brown; upper naked or bearded at the tip.

Locality: Konkan: Matheran, Harrison's Springs and Monkey Point (D' Almeida A251!, A252!).

Distribution: India, Ceylon, Java.

2. **Cyrtococcum pilipes,** A. Camus in Bull. Mus. Hist. Nat. 27 (1921), 118.—*Panicum pilipes*, Nees & Arn. ex Bühse in Miq. Pl. Jungh. iii, 376; Miq. F. Ind. Bat. iii, 453; Hook. f. F. B. I. vii, 57.—*P. hermaphroditum*, Steud. Syn. Gram. 67; Benth. Fl. Austral. vii, 485.—*P. oxyphyllum*, Hochst. ex Steud. l.c. 65.

Description: Perennial. Culms 30–60 cm. high, geniculately ascending from a slender, creeping, branching base, lower nodes rooting, upper subpubescent. Leaves 5–15 cm. long, 8–35 mm. broad, glabrous or sparsely hairy above, puberulous beneath, finely acuminate, base narrow. Sheath glabrous or ciliate, mouth hairy. Ligule rounded. Panicle 7–13 cm. long, contracted, branches short, rather remote, erect or spreading with short fastigiate branchlets, often slender hairs on the pedicels. Spikelets 1·5 mm. long, brown, very shortly pedicelled, glabrous. Lower involucral glume about ½ the length of the lower floral glume, obtuse, 3-nerved. Lower floral glume 5-nerved; upper white, its pale narrow, patent, hard.

Locality: Konkan: Above Kenery Caves (McCann A133!); Matheran (D'Almeida A132!, Woodrow!).—*Deccan:* Mahableshwar, in forests, elevation 4,500 ft., rainfall 270 inches Sedgwick & Bell 4801!); Pratapgad Fort (Bhide 1207!).—*S. M. Country:* Castle Rock, in shade of trees (McCann A131!, Bhide!); Belgaum (Herb. Bot. Gard Cal.!).—*Kanara:* Coastal forests, Karwar (Sedgwick & Bell 5113!); deciduous forests, Kirwatti (Sedgwick 3130!); Halyal (Talbot!); Supa, elevation 2,000 ft. (Talbot 2091!); Yellapore (Talbot 907!); Devimani Ghat (Hallberg & McCann A128!);

Gersoppa Falls (Hallberg & McCann A125 !) ; Anmod, forests (Sedgwick 3252 !) ; Kulgi, elevation 2,000 ft. (Talbot).

Distribution : Mascarene Islands, Madagascar, India, Malaya, Australia, Pacific Islands.

3. **Cyrtococcum patens,** A. Camus in Bull. Mus. Hist. Nat. 27 (1921), 118.—*Panicum patens*, Linn. Sp. Pl. 86 ; Burm. Fl. Ind. t. 10, f. 2 ; Spreng. Syst. i, 322 (*excl. syn. multinode*) ; Kunth Enum. Pl. 1, 126 (*excl. syn.* Roxb.) ; Hook. f. F. B. I. vii, 57.—*P. accrescens*, Trin. Sp. Gram. Ic. t. 88, *et corrig.* vol. iii ; Kunth l.c. 116.—*P. obliquum*, Roth. Nov. Sp. 51 ; Kunth l.c. 103 ; Miq. Fl. Ind. Bat. iii, 452.—*P. radicans*, Retz. Obs. iv, 18 ; Nees Agrost. Bras. 206 ; Kunth l.c. 216.

Description : Culms 30–90 cm. high, creeping and rooting and branched below, leafy, nodes glabrous. Leaves 5–15 cm. by 6–8 mm., ovate to linear-lanceolate, finely acuminate, thin, glabrous or ciliate below with tubercle-based hairs. Sheath with the margins and mouth ciliate. Ligule rounded. Panicle 5–13 cm. long, contracted or effuse, usually inclined with spreading glabrous or puberulous branches naked below, and very long distant spreading branchlets, rhachis, branches and pedicels capillary. Spikelets 1·5 mm. long. Lower involucral glume $\frac{1}{3}$–$\frac{2}{3}$ the length of the lower floral glume, ovate, obtuse, 3-nerved. Upper involucral and lower floral glume glabrous or with ciliate tips.—A very variable plant.

Locality : Konkan : Vasco da Gama (Bhide !) ; Vetora (Sabnis 33440 !).—*S. M. Country :* Tadas, in shade of trees, elevation 2,000 ft., rainfall 35 in. (Sedgwick 2102 !) ; Castle Rock (Gammie 15579 !), very large specimen (McCann A144 !).—*Kanara :* Nagargalli, forests, very abundant (Sedgwick 2892 !) ; Gersoppa Falls (Hallberg & McCann A126 !, Chibber !) ; Malamani, elevation 1,600 ft. (Talbot 2676 !) ; Kulgi (Talbot 2280 !) ; Guddhalli, Karwar (Hallberg & McCann A127 !).

Distribution : Tropical Asia, Malaya, Pacific Islands.

55. Sacciolepis, Nash in Britt. Man. Bot. 89 ; Stapf in Prain Fl. Trop. Afr. ix, 747.

Annual or oftener perennial grasses. Leaf-blades linear and flat or filiform-convolute, or filiform-subulate. False spikes often very dense, dark or variegated. Spikelets mostly very small, oblong to ovate-oblong or elliptic or lanceolate, subterete or laterally compressed, usually somewhat turgid, falling entire from the short finely filiform pedicels of a spiciform, very rarely open panicle. Involucral glumes similar in structure but unequal. Lower much shorter, softly or rigidly membranous, with a narrow hyaline margin or hyaline tip, stiffened by the hardening of the prominent and often rib-like nerves, or more or less dissimilar owing to the reduction of the lower glume to a small hyaline scale, or its differentiation into a narrow, hardened obscurely nerved back and broad hyaline margins. Upper with a curved or basally gibbous or saccate back, always much concave, mostly 7- or 9-, rarely 5- or up to 13-nerved. Lower floral glume male or barren, very dissimilar to the upper involucral glume and of the same or almost the same length, but with a straighter back ; pale narrow, hyaline, finely 2-keeled, shorter than the glume, sometimes reduced or quite rudimentary. Upper floral glume hermaphrodite, oblong in outline seen from the back, very convex, chartaceous, ultimately subcrustaceous, with firm narrowly involute margins, obscurely 5-nerved ; pale almost the length of the glume, tightly embraced by it all along and of the same texture, 2-nerved, hardly keeled. Lodicules two, small, broadly cuneate. Stamens three. Styles distinct ; stigmas long, loosely plumose, exserted terminally or subterminally. Grain tightly enclosed by the glume and pale, elliptic in outline, dorsally compressed, with an almost flat back and convex face ; hilum punctiform.

Species over 30.—Tropics of the whole world.

I. Lower involucral glume 3-nerved
  1. Spikes 1–5 cm. long. Spikelets lanceolate-ovoid, hispid, 2–2·5 mm. ... 1. *S. indica.*
  2. Spikes 5–23 cm. long. Spikelets ovoid, 1·3–2·1 mm. long ... 2. *S. myosuroides.*

II. Lower involucral glume 5-nerved ... 3. *S. interrupta.*

1. **Sacciolepis indica,** Chase in Proc. Biol. Soc. Wash. xxi (1908), 8; Haines Bot. Bihar & Orissa 990.—*Panicum indicum,* Linn. Mant. ii, 184; Retz. Obs. iii, 9; Kunth Enum. Pl. i, 133; Steud. Syn. Gram. 84; Roxb. Fl Ind. i, 285; Benth. Fl. Hongk 413, Fl. Austral, vii, 480; Hook. f. F. B. I. vii, 41 (*partim, excl. aliquibus syn.*).—*Hymenachne indica*, Bühse ex Miq. Fl Ind. Bat. iii, 458.

Description : A slender grass, 15–60 cm. high. Leaves linear-acuminate, 5–13 cm. long, up to 4 mm. wide, glabrous or hirsute, base narrow; sheath not auricled. Panicle spiciform, oblong or cylindric, dense-flowered, green or slightly purplish, 1–5 cm. long by about 4 mm. diam., branches very short. Spikelets longer than their pedicels, 2–2·5 mm. long, crowded, ovoid, acute or acuminate, straight or curved, shortly or hispidly hairy, or glabrous. Lower involucral glume ovate, $\frac{1}{3}$–$\frac{1}{2}$ of the lower floral glume, lanceolate from a broad base, acute, 3-nerved; upper usually subcymbiform, curved, obtuse, 7-11-nerved, 2·5 mm. long. Lower floral glume as long as the upper involucral glume, broadly ovate, obtuse, 9-nerved, pale minute; upper narrowly ellipsoid, very acute, white, smooth, polished, sides overlapping the margins of the similar pale, base obtuse, mucronulate with remains of the rhachilla.

Note.—Stapf has separated *Panicum angustum,* Trin. Sp. Gram. Ic. t. 334 from *Panicum indicum,* Linn. as conceived by Hook. f., and named it *Sacciolepis angusta.* In his opinion the various varieties given in the F.B.I. are mostly referable to *S angusta,* Stapf.

S. indica is not a well-defined species. It appears to pass insensibly into *S. myosuroides* and *S. interrupta.* According to Hook. f., the former differs in its caudiform spike and more minute rounded spikelets, the latter in its stouter habit.

Haines thinks it is better to confine *S. indica* to those specimens with hairy spikelets. We have not followed him in this.

Locality : S. M. Country : Khanapur, elevation 2,500 ft., rainfall 70 inches (Sedgwick 3080 !); Castle Rock (Bhide!).—*Kanara :* Tank near Yellapore (Talbot !); Kulgi (Talbot 2291!): Siddhapur to Sirsi (Hallberg & McCann A118 !); Karwar (Talbot 1297 !, Hallberg & McCann A116 !).

Distribution : Tropical Asia and Australia.

2. **Sacciolepis myosuroides,** Haines Bot. Bihar & Orissa 990.—*Panicum myosuroides*, R. Br. Prodr. (1810), 189; Kunth Enum. Pl. i, 77; Steud Syn. Gram. 56; Benth. Fl. Austr. vii, 480 (*excl. syn. angustum*); Duthie Fodd. Grass. N. Ind. 11; Hook. f., F.B.I. vii., 42; Trim. Fl. Ceyl. v, 148; Prain Beng. Pl. 1175; Cke ii, 934.—*P. curvatum,* Roxb. Fl. Ind. i, 286 (*non* Linn.).

Description : Cke. l.c.

Locality : Konkan : Savantvadi (Woodrow); Alibag (Lisboa).—We have not seen any specimen.

Distribution : India, Ceylon, Malay Peninsula, China, Australia.

3. **Sacciolepis interrupta,** Stapf in Prain Fl. Trop. Afr. ix, 757; Haines Bot. Bihar & Orissa 991.—*Panicum interruptum,* Willd. Sp. Pl. i, 341; Kunth Enum. i, 87; Nees Fl. Afr. Austr. 51; Roxb. Fl. Ind. i, 286; Griff. Notul. iii, 26, and Ic. Pl. Asiat. t. 139, fig. 221, t. 146, fig. 2; Dalz. & Gibs. 316; Steud. Syn. Pl. Glum. i, 66; Hook. f. F.B.I. vii, 40; Stapf in Dyer Fl. Cap. vii, 413.—*P. uliginosum,* Roth Nov. Pl. Sp. 50.—*P. inundatum,* Kunth Rev. Gram. i, 34, and Enum. i, 88; Steud. l.c. 66.—*Hymenachne interrupta,* Bühse in Miq. Pl. Jungh i, 377; Miq. Fl. Ind. Bat. iii, 458; Steud. l.c. 101.—*P. indicum,* Hack. in Bolet. Soc. Brot. v, 210 (*non* Linn.).

Description : Cke. l.c.

Very variable in size and shape, especially the panicle which varies a good deal as to colour.

Locality : Sind : (Woodrow *teste* Cooke).—*Konkan :* Bassein, tank (Burns!); Wada, tank (Ryan 453!); Nagotna (Gammie 16074!); Borivli-Kanary, in water (McCann A120 !); Bhivandi (Chibber !); Vihar (Sabnis !); Gokura Creek, Bassein (Garade 1708 !); Virar, on bank of a tank (McCann 9583 !); Panvel (Woodrow); Vengurla (Woodrow); margins of tanks throughout the Konkan (Dalzell & Gibson).—*Deccan :* Tingerwadi, Igatpuri (Blatter & Hallberg 3825 !).—*S. M. Country :* Tadas, tanks (Sedgwick & Bell 4916 !); Londa, in water (Gammie 15854 !); Hulkop (Sedgwick & Bell 3174 !); Belgaum (Herb.

Econ. Bot. Poona !). —*Kanara :* Sirsi-Siddhapur (Hallberg & McCann A117 !) ; Tinai Ghat (Gammie 15791 !)

Usually inhabiting marshy and swampy places such as rice fields and the banks of tanks.

It is doubtful as to whether Woodrow's plant from Sind was correctly named as this grass is one of moist regions.

Distribution : Tropical and S. Africa, India, Ceylon, Malaya.

56. SETARIA, P. Beauv. Agrost. 51, t. xiii, fig. iii ; Cke. ii, 918.

(In 1897 F Lamson Scribner (in U. S. Dept. Agr. Div. Agrost. Bull. iv, 38) proposed the name *Chætochloa* for the grasses generally known as *Setaria.* Stapf has given convincing reasons why the old name should be retained. See Kew Bull (1920), 124–127.

Species about 100.—Warm regions of the World, a few species common as weeds in the more temperate parts. Cooke has 5 indigenous and 1 cultivated species. We retain them all.

Key :

A. Leaves more of less plicate
- I. Perennial. Culm reaching 2·4 m. ... 1. *S. plicata.*
- II. Annual. Culm reaching 0·6 m. ... ... 2. *S. rhachitricha.*

B. Leaves flat, not plicate
- AA. Bristles not retrorsally barbellate
  - I. Upper floral glume smooth ... ... 6. *S. italica.*
  - II Upper floral glume rugose
    - 1. Panicle spiciform, continuous ; bristles 6 or more... ... ... 3. *S. glauca.*
    - 2. Panicle interrupted or subpyramidal ; bristle 1 on pedicel and usually 3-4 below pedicel ... ... 4. *S. intermedia.*
- BB. Bristles retrorsally barbellate ... 5. *S. verticillata.*

1. **Setaria plicata,** T. Cooke in Fl. Bomb. ii, 919.—*Panicum plicatum*, Lam. Ill. 1 (1791), 171 ; Jacq. Eclog. Gram. i. t. 1 ; Trin. Gram. Panic. 183, Gen. Pan. 161, Sp. Gram. Ic. t. 223 ; Kunth Enum. Pl. i, 94 ; Griff. Notul. iii, 24, Ic. Pl. Asiat. t. 139, fig. 229 ; Duthie Grass. N. W. Ind. 6, Fodd. Grass. N. Ind. 11 ; Benth. Fl. Hongk. 411 ; Hook. f. F. B. I. vii, 55 ; Trim. Fl. Ceyl. v, 157. —*P. amplissimum*, Steud. Syn. Gram. 54.—*P. asperatum*, Kunth Rev. Gram. i, 39, Enum. Pl. l. c. 39 ; Miq. Fl. Ind. Bat. iii, 456.—*P. excurrens*, Trin. Pan. Gen. 131, 249, Sp. Gram. Ic. t. 49 ; Benth Fl. Hongk. 412 (*excl. syn.*).—*P. nepalense*, Spreng. Syst. 321 ; Dalz. & Gibs. 291 ; Aitchis. Cat. Panjab Pl. 160.—*P. nervosum*, Roxb. Fl. Ind. I, 311.—*P. neurodes*, Schult. Mant. II, 228 ; Duthie Grass. N. W. Ind. 5.—*P. Wallichianum*, Nees Fl. Afr. Austr. 49.

Description : Cke. ii, 919.

Locality : Konkan : Victoria Gardens, Bombay (McCann 5376 !) ; Parel (Lisboa) ; western side of the Ghats (Dalzell & Gibson).—*Deccan* : Lingmala, Mahableshwar, in forest (Sedgwick & Bell 4642 !) ; Panchgani, (Blatter & Hallberg B1234 !, B1235 ! McCann !).—*S. M. Country :* Belgaum Fort, common all over Belgaum in compounds (Sedgwick 3066 !).—*Kanara :* Kulgi (Talbot 2278 !) ; Halyal (Talbot 2408 !).

Distribution : India, Ceylon, Malay Peninsula and Islands, China.

Uses : Sometimes cultivated as an ornamental grass.

2. **Setaria rhachitricha,** T. Cooke in Fl. Bomb. ii, 919.—*Panicum rhachitrichum*, Hochst. in Flora 27 (1844), 254 ; Parlat. in Hook. Niger Fl. 187 ; Steud. Syn. Gram. 63 ; Hook. f. F. B. I. vii, 56 ; Prain Beng. Pl. 1176.—*P. chamaeraphis*, Nees ex. A. Braun In. Sem. Hort. Berol. (1853) Append. 20.—(*P. homonymum*, Steud. l.c. 48 ; Duthie Grass. N. W. Ind. 4 (*homogynum*).

Locality : S. M. Country : Londa (Gammie ex Woodrow).

We doubt the occurrence of this species in the Presidency. Neither Cooke nor we have seen any specimens. There are none in Herb. Kew, neither do the herbaria of the Presidency contain any. Besides, the distribution of the species is not in favour of its presence in Bombay.

Distribution : India (subtropical Himalaya, Chota Nagpur, Calcutta), tropical Africa.

3. **Setaria glauca,** Beauv. Agrost. (1812), 51; Kunth. Enum. Pl. i, 149, Suppl. 106; Griff. Notul. 44, Pl. Asiat. t. 149. f. 1; Dalz. & Gibs, 293; Aitchis. Cat. Punjab, Pl. 162; Miq. Fl. Ind. Bat. iii, 466; Duthie Grass. N. W. Ind. 8, Indig. Fodd. Grass. t. x, Fodd. Grass. N. Ind. 14; Boiss. Fl. Or. v, 442; Hook. f. F. B. I. vii, 78; Trim. Fl. Ceyl. v, 162; Prain Beng. Pl. 1170; Cke. ii, 920.—*Panicum glaucum*, Linn. Sp. Pl. 76; Trin. Sp. Gram. Ic. t. 195; Roxb. Fl. Ind. i, 285; Benth. Fl. Hongk. 411.—*P. lutescens*, Weig Obs. (1772), 20.—*Setaria lutescens*, Hubbard in Rhodora xviii (1916), 232.—For other synonyms see Hook. f. l. c.

Mr. C. E. Hubbard of the Kew Herbarium informs us that he changed *Setaria glauca*, Auct. into *S. lutescens* on account of the synonym *Panicum lutescens*, Weigel Obs. (1772), 20. Dr. Stapf thinks that this name change is unnecessary and we quite agree with him after reading his MS. on this question which he kindly allowed Mr. Hubbard to put at our disposal. As Dr. Stapf is now about to publish his MS. we refrain from giving his arguments in this place.

Description : Cke. ii, 920.

Locality : Gujarat : Nadiad (Chibber !); Ahmedabad (Saxton 1063 !); Baroda (Cooke).—*Khandesh* : Toranmal (McCann A149 !, A150 !); N. slope of Chanseli (McCann A151 !).—*Konkan* : Bhandup (McCann 3606 !); Mulgaum (McCann A147 !); Bassein (McCann 9607 !); Sion (McCann 3573 !); Thana (Lisboa).—*Deccan:* Shivner Fort, Junnar (Paranjpe!); Mahableshwar, common (Woodrow !, Dalzell & Gibson, Cooke); Panchgani, behind Maratha well (Blatter 3824 !); Chattarshinji Hill, Poona (Ezekiel !); Shewapur, near Poona (Bhide 981 !); Khandala, very common (McCann 8406 !); Purandhar, foot (McCann 5603 !); Lohagad, top (McCann 9501 !); Nasik (Lisboa).—*S. M. Country :* Dharwar Dist. (Sedgwick 2173 !); Dumbai, under trees (Talbot 2300 !).—*Kanara :* Dandeli (Bell 4224); Halyal (Talbot 2144 !); Onore (Talbot 1063 !).

Distribution : All warm, temperate and tropical regions.

4. **Setaraia intermedia,** Roem. & Schult. Syst. ii (1817), 489; Kunth Enum. Pl. i, 150; Aitchis. Cat. Panjab. Pl. 162; Duthie Grass. N. W. Ind. 9, Fodd. Grass. N. Ind. 14; Hook. f. F. B. I. vii, 79; Trim. Fl. Ceyl. v, 163; Cke. ii, 920; Haines Bot. Bihar & Orissa 989.—*S. glauca*, Hochst. Pl. Hohenack. no. 937.—*Panicum intermedium*, Roth. Nov. Sp. 47.

Description : Cke. ii, 920.

Locality : Gujarat : Doongri (Chibber !); Ahmedabad (Gammie 16351); Nadiad (Chibber !).—*Khandesh :* Toranmal (McCann A152 !); Umalla village (Blatter & Hallberg 5184 !).—*Konkan :* Dadar, very common in Bombay Isl. (McCann A153 !); common in Salsette (McCann !).—*Deccan :* Purandhar Fort (Bhide !, McCann 5595 !, 5022 !); Chattarshinji, Poona (Bhide !); in cultivated fields about Poona (Jacquemont 355); Igatpuri, common (McCann 4320 !); Khandala, common (Blatter 4410 !, McCann !); Lonavla (McCann 4466 !); Panchgani (Blatter & Hallberg B1227 !, B1272 !).—*S. M. Country* : Dharwar (Sedgwick 1839 !); Belgaum (Ritchie 839).—*Kanara :* Yellapore (Talbot 1520 !); Halyal (Talbot 2296 !).

Distribution : Temperate and tropical regions.

5. **Setaria verticillata,** Beauv. Agrost. (1812), 51; Kunth Enum. Pl. I, 152; Dalz. & Gibs. 294; Aitchis. Cat. Panjab Pl. 162; Duthie Grass. N. W. Ind. 9, Fodd. Grass. N. Ind. 15; Reichb. Ic. Fl. Germ. t. 47; Hook. f. F. B. I. vii, 80; Trim. Fl. Ceyl. v, 163; Prain. Beng. Pl. 1170; Cke. ii, 921; Haines Bot. Bihar & Orissa 989.—*S. respiciens*, Hochst. ex. Miq. Fl. Ind. Bat. iii, 467.—*Panicum adhaerens*, Forsk. Fl. Aegypt.—Arab. 20.—*P. verticillatum*, Linn. Sp. Pl. ed. ii, 82; Roxb. Fl. Ind. i, 301; Trin. Sp. Gram. Ic. t. 202.—*Pennisetum verticillatum*, Br. Prodr. 195.—Other synonyms in Hook. f. l. c.

Description: Cke. ii, 921.

Locality : Sind : Umerkot (Sabnis B748 !); Sanghar (Sabnis B758 !); Mirpurkhas, cultivated fields (Sabnis B701 !); Bughar, Indus River (Blatter & McCann D640 !); Ghulamalla, garden (Blatter & McCann D641 !); Mirpur Sakro (Blatter & McCann D642 !).—*Gujarat :* Ahmedabad (Sedgwick !); Cutch (Blatter 3744 !); Baroda (Woodrow); Morvi, Kathiawar (Woodrow).—*Konkan :* Sion (Herb. S.X.C. 5236 !); Juvem (Herb. S.X.C. 4237 !); Malabar Hill (McCann 3626 !); Byculla (McCann !) —*S. M. Country :* In a village, Dharwar Dist. (Sedgwick 3109 !).

Distribution : India, Ceylon, temperate and tropical regions.

*6. **Setaria italica,** Beauv. Agrost. (1812), 51; Reichb. Ic. Fl. Germ. t 47; Aitchis. Cat. Panjab Pl. 162; Duthie Grass. N. W. Ind. 8, Field and Gard. Crops 5, t. 25, Fodd. Grass. N. Ind. 15; Miq. Fl. Ind. Bat. iii 467; Hook. f. F. B. I. vii, 78; Prain Beng. Pl. 1170; Haines Bot. Bihar & Orissa 988.—*Panicum italicum,* Linn. Sp. Pl. (1753), 56; Roxb. Fl. Ind. i, 302; Dalz. & Gibs. Suppl. 98.—*Pennisetum macrochaetum,* Jacq. Eclog. Gram. iii, 36, t. 25.- Rheede Hort. Malab. xii, t. 79—For other references see Hook. f. l.c.

Vern. Names : Italian millet, foxtail millet, rala.

Description : Annual. Culms erect, tufted, 0·6—1·5 m. high Leaves linear or lanceolate-linear, acuminate, 7-10 mm. broad or broader. Sheath densely ciliate on margin and mouth. Panicle 7-13 cm. long, 10 mm. wide or more, dense, inclined or nodding, simple, cylindric or lobed or compound; rhachis very hairy. Spikelets oval, 2-2·5 mm. long, in small clusters on the abbreviated branchlets of the panicle, with 2-3 bristles below each pedicel, bristles nearly smooth or microscopically barbellate, 5-8 mm. long, barbs suberect or spreading. Lower involucral glume oblong or subglobose, hyaline, smooth; upper ovate, obtuse or rounded, about ¾ the length of the upper floral glume, 5-nerved. Lower floral glume hyaline, delicately 4-5-nerved, as long as and same shape as the upper floral glume, but not concave. Upper floral glume oval or elliptic or subglobose, concave, hardening, variable in length, not rugose but smooth and microscopically cancellate.

Locality: Konkan: Bombay, cultivated in compound of the Training College (McCann 4286 !); Bassein, Botanic Garden (Joshi !); Chowpatti, Bombay (Herb. S.X.C. 4299 !).—*Deccan :* Ganeshkhind Botanic Gardens(Patwardhan !). —*S. M. Country:* Dharwar, cultivated (Talbot 2014 !).

Extensively cultivated throughout as a food-grain.

Distribution: Most warm, temperate and tropical countries.

Origin: See DeCandolle, Origin of cultivated plants, p. 378.

57. SPINIFEX, Linn. Mant. ii, (1771), 163; Cke. ii, 913.

Species 4,—1 in India, 3 in Australia.

1. **Spinifex squarrosus,** Linn. Mant. (1771), 300; Lam. Ill. t. 840; Duthie Grass. N. W. Ind. 11; Benth. Fl. Hongk. 415; Miq. Fl. Ind. Bat. iii, 474; Hook. f. F.B.I. vii, 63; Grah. Cat. 240; Trim. Fl. Ceyl. v. 5; Prain Beng. Pl. 1168; Cke. ii, 913; Haines Bot. Bihar & Orissa 1010.—*Stipa littorea,* Burm. f. Fl. Ind. 29.—*Stipa spinifex,* Linn. Mant. i, 84; Rheede Hort. Mal. xii, t. 75

Description: Cke. l.c.

Locality: Gujarat: Near Domas (Cooke).—*Konkan:* Vengurla (Chibber !); Juvem (McCann 4263 !); Versova (McCann 9827 !); Bandra (Blatter !); sandy shores near Bandra (Graham); Shrivardhan (Woodrow) —*Kanara :* Sandy sea shore, Karwar (Sedgwick & Bell 5057 !, 5056 !); Kumpta (Chibber !, Woodrow); Honavar, very common (McCann !, Chibber !); Onore (Talbot 1073 !).

Distribution: India, Ceylon, Java, China.

Uses: A valuable sand-binding plant.

58. TRICHOLÆNA, Schrad. in Schult. Mant. ii (1824), 163; Cke. ii, 924.

Species 10-12.—Chiefly African. The following 2 in the Bombay Presidency.

1. **Tricholæna Teneriffæ,** Parlat. in Welb. & Berth. Phyt. Canar. iii, pt. 2 (1848), 425; Hook. f. F.B.I. vii, 65; Cke. ii, 924.—*Saccharum Teneriffæ,* Linn. f. Suppl. 106.—For further synonyms see Hook. f. l.c.

Description: Cke. l.c.

Locality: Sind : Laki (Bhide !); Thano-Bullo-Khan (Woodrow).

Distribution: Punjab, W. Peninsula; westward to Sicily and N. Africa.

2. **Tricholæna Wightii,** Nees ex Steud. Syn. Gram. (1855), 93; Lisboa in Journ. Bomb. Nat. Hist. Soc. v, (1890), 347; Hook. f. F.B.I. vii, 65; Cke. ii, 925.—*Rhynchelytrum Wightii,* Duthie Fodd. Grass. N. Ind. 21.—For further synonyms see Hook. f. l.c.

Description : Cke. l.c.

Locality : Konkan : Commonly cultivated in gardens in Bombay (McCann !); Sewri, probably an escape (Hallberg 3592 !).—*Deccan :* Diva Ghat (McCann

5590 !) ; Malhargad (Woodrow) ; Poona (Woodrow) ; Mahableshwar (Lisboa) ; Panchgani (Lisboa).—*S. M. Country:* Badami (Bhide !, Woodow 23).

Distribution: India (Rajputana, W. Peninsula), Arabia, CapeVerd Islands.

5). PENNISETUM, Pers. Syn. i, (1805), 72 ; Cke. ii, 914.

Species about 40.—In most warm countries.

Cooke has 6 indigenous and 1 cultivated species. We add another cultivated species : *P. purpureum*, Schum. & Thoun. The name *P. cenchroides*, Rich. has to cede to *P. ciliare*, Link., and *P. typhoideum*. Rich. to *P. spicatum*, Roem. & Schult.

A. Anther-cells not bearded at the tips
- I. Bristles of involucel free to the base
  - 1. Inner bristles of involucel scaberulous, not ciliate
    - (*a*) Leaves 30-45 cm. long ... 1. *P. Alopecuros.*
    - (*b*) Leaves 7-15 cm. long ... 2. *P. dichotomum.*
  - 2. Inner bristles of involucel ciliate below the middle, but naked at the base. Involucel stripitate ... ... 3. *P. orientale.*
  - 3. Inner bristles of involucel densely villous or ciliate below the middle, not naked at the base. Involucel sessile
    - (*a*) Inner bristles of involucel densely villous ... ... 4. *P. pedicellatum.*
    - (*b*) Inner bristles of involucel laxly ciliate with long silky hairs, not villous ... ... 5. *P. setosum.*
- II. Inner bristles of involucel dilated below, their bases confluent in a coriaceous disk ... ... 6. *P. ciliare.*

B. Anther-cells more or less bearded at the tips Styles connate
- I. Culms less than 2 m. high. Pale of upper floral glume truncate ... .. 7. *P. spicatum.*
- II. Culms more than 2 m. high. Pale of upper floral glume minutely 2-toothed ... 8. *P. purpureum.*

1. **Pennisetum Alopecuros**, Nees ex Steud Syn. Gram. (1855) 102 ; Duthie Grass. N. W. Ind. 10 ; Lisboa in Journ. Bomb. Nat. Hist. Soc. v. (1890), 338 ; Hook. f. F.B.I vii, 84 ; Cke. ii, 914.—*P. Hohenackeri*, Hochst. ex Steud. l.c. 103.—*P. aureum*, Dalz. & Gibs. 294 —*Gymnothrix Alopecuros*, Nees in Wight Cat. no. 1663 ; Steud. l.c.—*G. cenchroides*, Roem. & Schult. Syst. ii 499.

Description : Cke. l c.

Locality : Sind : (Dalzell).—*Gujarat :* N. Sonasan, on dry sandy bank (Sedgwick !).—*Khandesh :* Toranmal, very common around lake (McCann 9862 !).—*Deccan :* Poona (Woodrow !, Lisboa, Jacquemont 407) ; near Poona (Gammie 15314 !) ; Nasik (Bourke !, Blatter & Hallberg 9863 !, Lisboa) ; Purandhar, N foot (McCann 5045 !) ; Lohagad, plain (McCann 9502 !) ; Panchgani (Blatter 3802 !, Blatter & Hallberg 1292 !, McCann !) ; Lonavla (Lisboa).—*S. M. Country :* Dharwar (Sedgwick 3718 !) ; Londa (Gammie 15827 !) ; Belgaum (Woodrow).—*Kanara :* Halyal (Talbot 2090 !).

Commonly found in clumps on sandy soil near streams and lakes. It is extremely tough and occupies sometimes large patches of land excluding almost everything else. *Dichanthium caricosum* is commonly found growing together with this grass.

Distribution : Rajputana, C. India, W. Peninsula.

Uses : 'In Poona brooms are said to be made of it, and at Mt. Abu it is employed in the manufacture of cordage.' (Lisboa).

2. **Pennisetum dichotomum**, Del. Fl. d'Egypt. (1813), 159, t. viii, fig. 1., Trin. Diss. ii, 66, Pan. Gen. 94 ; Kunth Enum. Pl. i, 161. Suppl. 110 ; Steud. Syn Gram. 105 ; Boiss. Fl. Or. v, 444 ; Aitchis. Cat. Panjab Pl. 162 ; Duthie Grass. N. W. Ind. 10 ; Hook. f. F.B.I. vii, 85 ; Aschers.—Schweinf. Ill. Fl. d'Eg. 161, No. 1131 ; Cke. ii, 915.—*P. phalaroides*, Schult. Mant. ii, 147.—*Gymnothrix longiglumis*, Munro in Cat. Griff. etc. Pl. 56 (*nomen*).—*Cenchrus ramosissimus*,

Poir. Encycl. vi, 51 ; Dalz. & Gibs. 294.—*Phalaris retacea*, Forsk. Fl. Aegypt. —Arab. 20.—*Panicum dichotomum*, Forsk. l.c.

Description : Cke. l.c.

Locality : Sind : On sand hills (Stocks, Woodrow) ; Bholari (Bhide !) ; Nasarpur, sandy plains (Sabnis B1050 !) ; Sehwan, sand dunes (Sabnis B673 !).—*Gujarat :* In hedges (Dalzell & Gibson).

Distribution : Punjab, N. W. Provinces, W. Peninsula, Afghanistan, Persia, Arabia, Syria, Sinai, Egypt.

Uses : Collected for fodder, one of the most valuable of desert plants.

3. **Pennisetum orientale,** Rich. in Pers. Syn. i (1805), 72 ; Boiss. Fl. Or v, 445 ; Duthie Grass. N. W. Ind. 10 ; Hook. f. F.B.I. vii, 86 ; Cke. ii, 915 ; Muschler Fl. Egypt (1912), 66 ; Haines Bot. Bihar & Orissa 986.—*P. arenosum*, Edgew. in Journ. As. Soc. Beng. xxi (1852), 180 ; Aitchis. Cat. Panjab Pl. 162 ; Duthie Grass. N. W. Ind. 10.—*P. persicum*, Boiss. & Bühse in Nov. Mem. Soc. Nat. Mosc. xii (1860), 232.-*P. sinaicum*. Dcne. in Ann. Sc. Nat. ser. 2. ii (1834), 11 ; Aitchis. l.c. ; Duthie l.c.—*P. tiberiadis*, Boiss. Diagn. ser i, xiii. 43.—*Cenchrus orientalis*, Willd. ex Trin. Diss, ii, 69.—*Panicum orientale*, Willd. Enum. Hort. Berol. ii. 1031.

Description : Cke. ii, 915.

Locality : Sind : Hyderabad (Woodrow !) ; Mirpurkhas (Mankhad !).—*Konkan :* Victoria Gardens, Bombay (McCann 4385 !).

Distribution : W. Himalaya, Punjab, W. Peninsula, Persia, Syria, Cilicia, Sinai, Egypt, Algeria.

4. **Pennisetum pedicellatum,** Trin. in Mém. Acad. Pétersb. sér. 6, iii, pt. 2 (1835), 184 : Hook. f. F.B.I. vii, 86 ; Cke. ii, 916 ; Haines Bot. Bihar & Orissa 986.—*P. lanuginosum*, Hochst. in Flora xxv (1842), Beibl. i, 133 ; A. Rich. Tent. Fl. Abyss. ii, 385 ; Lisboa in Journ. Bomb. Nat. Hist. Soc. v (1890), 339.—For further synonyms see Hook. f.

Description : Cke. ii, 916.

Locality : Gujarat : (Lisboa) ; Rajkot (Woodrow).—*Khandesh :* Toranmal in watercourse (McCann 9868 !).—*Deccan :* College Farm, Poona (Garade !).

Distribution : Bihar, Rajputana, W. Peninsula, tropical Africa.

5. **Pennisetum setosum,** Rich. in Pers. Syn. i (1805), 72; Hook. f F.B.I. vii, 87, Cke. ii, 916 ; Haines Bot. Bihar & Orissa 986.—*P. barbatum*, Schult. Mant ii, 147.—*P. holcoides*, Schult l.c. 148 ; Duthie Grass. N.W. Ind. 10, Indig. Fodd. Grass. t. 49, Fodd. Grass. N. Ind. 17.—*P. purpurascens*, H. B. & K. Nov. Gen. & Sp. i, 113.—*Panicum barbatum*, Roxb. Fl. Ind. i, 282.—*Panicum holcoides*, Roxb. l.c. 285.

Description : Cke. ii, 916.—Our specimens from Khandesh have the bristles quite free from hairs.

Locality : Sind : Hyderabad (Woodrow).—*Gujarat :* Ahmedabad, No. 6 grass plot Bhadar (Sedgwick !).—*Khandesh :* To Toranmal (McCann 9869 !) ; Chanseli Hill, S. slope (McCann 9867 !).

Distribution : India (W. Bengal, Bihar, Upper Gangetic Plain, W. Peninsula), tropical Africa and America.

6. **Pennisetum ciliare,** Link. Hort. Berol i (1827), 213 ; Boiss. Fl. Or. v, 445 ; Aschers.-Schweinf. Ill. Fl. d'Eg·161, no. 1132 ; Sickenberg Contrib. Fl. d'Eg. 301 ; Muschler Fl Eg. i, 65.-*Cenchrus ciliaris*, Linn Mantiss. ii, 302 ; Desf. Fl. Atlant. ii, 387.-*Pennisetum cenchroides*, Rich in Pers. Syn. i (1805), 72 ; Beauv. Agrost. 59, t 13, f. 5 ; Aitchis. Cat. Panjab Pl. 162 ; Lisboa in Journ. Bomb. Nat. Hist. Soc. v (1890), 338 ; Duthie Grass. N.W. Ind. 10, Indig. Fodd. Grass. t. 12, 13, Fodd. Grass. N. Ind. 17.

Vern. Names : Jiral, Anjan, Dhaman (Sind), Vaghnoru (Gujarat).

Description : Cke. ii, 916.

Locality : *Sind :* (Burns !); Mirpurkhas (Mankad !, Sabnis B1043 !); Jacobabad (Deputy Commissioner !); Sanghar (Sabnis B892 !); Clifton near Karachi (Sabnis B805 !); Jamadar ka Landa, near Karachi (Stocks); Sehwan to Laki (Sabnis B620 !); Nasarpur (Sabnis B1056 !); Umerkot, sand dunes (Sabnis B1079 !); Tatta, Kullan Kote Lake (Blatter & McCann D630 !, D631 !, D633!), Tatta (Blatter & McCann D632 !, D634 !, D635 !)!; Indus Delta (Blatter & McCann D636!).—*Gujarat:* Nadiad (Chibber !); Dohad, (Chibber !); Daman (Bhide !); Surat (Gammie !); Ahmedabad (Sedgwick !); near Madalpur,

Ahmedabad (Saxton 1065 !); Bhuj Hill, Cutch (Blatter 3767 !); Rajkot, Kathiawar (Woodrow).—*Khandesh*: Tapti bank, Muravad (Blatter & Hallberg 51651 !); Umalla, Tapti bank (Blatter & Hallberg 5208 !).—*Deccan*: (Lisboa !). —*S.M. Country*: Gokak (Shevade !).

Distribution: India (Kashmir, Upper Gangetic Plain, W. Peninsula, Deccan), throughout Africa, Sicily, Canaries.

7. **Pennisetum spicatum**, Roem. & Schult. Syst. Veg. ii (1817), 499.—*Panicum spicatum.* Roxb. Fl. Ind. i, 283.—*Penicillaria spicata*, Willd. Enum. Hort. Berol. 1037; Aitchis. Cat. Punjab Pl. 163.—*Holcus spicatus*, Linn. Syst. ed, x, 1305; Grah. Cat. Bomb. Pl. 238; Dalz. & Gibs. Suppl. 99.—*Pennisetum typhoideum*, Rich. in Pers. Syn. i (1805), 72; Boiss. Fl. Or. v, 447; Duthie Grass. N.W. Ind. 11, Field and Gard. Crops 30, t. 71, Fodd. Grass. N. Ind. 18; Lisboa in Journ. Bomb. Nat. Hist. Soc. v (1890), 339; Hook. f. F B.I. vii, 82; Prain Beng. Pl. 1169; Cke. ii, 917; Haines Bot. Bihar & Orissa 985.—*Panicum americanum*, Linn. Sp. Pl. i, 56.—*Pennisetum americanum*, K. Schum. in Engl. Pflanzenw. Ost.—Afr. B. (1895), 51; Hitchc. in Bailey Cyclop. Hortic. 2537.—*Holcus racemosus*, Forsk. Fl. Aegypt.—Arab. (1775), 175.—*Alopecurus indica*, Burm. Fl. Ind. 27.

In order to explain the above synonymy and the final adoption of the specific name *P. spicatum* we reproduce a MS. note kindly sent to us by Mr. Hubbard:

"*Pennisetum typhoideum* L. Rich. in Pers. Syn. i. 72 (1805) has been changed to *Pennisetum americanum* by K. Schum. in Engl. Pflanzenw. Ost.-Afr. B. 51 (1895), based on *Panicum americanum* L. Sp. Pl. ed. i. 56, (1753) *Panicum americanum* L. in turn, is based on *Panicum americanum* Clusius Hist., ccxv (1601). Hitchcock in Contr. U. S. Nat. Herb. xxii. 218 (1921) suggests that the figure (in Clusius) is that of the 'common millet' (*Setaria italica*) and that the description is based on more than one species. I do not think the figure is that of the 'common millet', it is however very similar to a form of 'pearl millet' cultivated in Spain; in addition Clusius says that his *Panicum americanum* grows as tall as a man and has stouter, thicker stems than the common millet which he calls *Panicum vulgare* and figures on the same page. In the second edition of the Species Plantarum, 1484 (1763), Linnæus quotes *Panicum americanum* in synonomy under *Holcus spicatus* L. (first published in Syst. Nat. ed. x. ii. 1305 (1759); this is the basis of *Pennisetum spicatum* Roem. *et* Schult. Syst. Veg. ii. 499 (1817). It appears advisable to use this name in preference to *Pennisetum americanum* K. Schum., owing to the uncertainty as to what *Panicum americanum* Clusius really is and also the name '*americanum*' is misleading."

Vern Names: Bajri, bulrush millet, cat-tail millet, pearl millet.

Description: Annual. Culms tall, erect, stout, terete, 0·9—1·8 m. high, rooting at the lower nodes, sometimes woolly, pubescent below the inflorescence. Leaves 30–90 cm. by 6–50 mm., linear to linear-lanceolate from a rounded base, acute, flat, more or less rough, glabrous, rarely hirsute; sheath terete, rather inflated, glabrous except the bearded nodes and the often villous junction with the blade, rarely hirsute, usually slightly rough, rather shorter than the internodes, ligule a narrow, long and densely ciliate rim. Panicle spike-like, cylindric, very dense, 10-20 cm. long, often purplish; rhachis stout, villous; branchlets reduced to a peduncled involucrate cluster of 1–8 spikelets; peduncles villous, straight, 2·5—5 cm. long, often horizontally spreading or partly deflexed; involucre of very numerous ciliate often purplish bristles about as long as the spikelets. Spikelets sessile or shortly pedicelled within the involucre, readily deciduous when ripe, oblong, 5-6 mm. long, pale or purplish upwards. Lower involucral glume minute or 0, half-orbicular or subquadrate, 1–3-nerved; upper variable in length, sometimes absent, usually $\frac{1}{8}$–$\frac{1}{2}$ the length of the upper floral glume, subquadrate, truncate, obtuse or retuse, 3-nerved, very rarely as long as the upper floral glume and coriaceous. Lower floral glume ovate-oblong, obtuse or truncate and apiculate, 5-nerved, epaleate or paleate, male or neuter, rarely bisexual; upper coriaceous or herbaceous, ovate, acute, 5–7-nerved, pale very broad, truncate, ciliate at the tip and dorsally, nerves 2, approximate, excurrent. Lodicules 0. Anthers linear, 2·5 –3 mm. long, tips bearded. Styles connate. Grain oblong, obovoid, or pyriform, smooth, free, top exposed.

Locality: Cultivated throughout the Presidency.

Origin: Unknown. See Leeke. Untersuchungen über Abstammung und Heimat der Negerhirse.

8. **Pennisetum purpureum,** Schum. & Thonn. Beskr. Guin. Pl. 44; Stapf in Kew Bull. (1912), 309.—*P. macrostachyum*, Hook. Niger Flora 563.—*P. Benthamii*, Steud. Syn. Pl. Glum. i, 105.—*P. nitens*, Hack. in Bol. Soc. Brot. vi (1888), 142.—*Gymnothrix nitens*, Anderss. in Peters Reise nach Mossamb. vi (1864), 552.—*Pennisetum flexispica*, K. Schum. in Engl. Pflanzenw. Ost.-Afr. C (1895), 105.

Popular Name: Elephant Grass.

Description: Perennial. Rhizome creeping. Culms erect, in tufts of up to 20, 2–3 m. or occasionally up to 7 m. high by 1·2-2·5 cm. diam. at the base; branches obliquely erect, terete, glabrous, smooth, excepting the upper part of the uppermost internode which is more or less hairy to tomentose, exserted parts sometimes covered with a glaucous bloom; nodes mostly exserted from the sheaths, all glabrous or most of them or only the uppermost with a ring of stiff, long, appressed hairs. Leaf-blade linear, inserted on the sheath with a very marked hinge-fold, tapering upwards to a fine point, 30–60, rarely to 90 cm. long by 2·5 cm. diam., with a strong midrib, rounded or the back with a shallow channel above towards the base, and in the larger leaves with 6 or 7 slightly prominent primary nerves on each side, dull green, sometimes slightly glaucous or tinged with purple, more or less rough on both sides, glaucous beneath, usually more or less hairy above, especially towards the base which sometimes becomes fringed, hairs fine, mostly rather stiff and long and often springing from small tubercles; margins spinulosely scabrid. Sheaths terete, clasping the stem, striate, glabrous and smooth or pubescent to hirsute with tubercle-based hairs near the top. Ligule a narrow rim bearing a dense fringe of white hairs 2 or 3 mm. long. Inflorescence a dense, cylindric, erect spike, 8–20 and even 30 cm. long and 1·5–3 cm. diam., yellow or tinged with brown, purple or quite blackish-purple, made up of deciduous spikelets or fascicles of spikelets, each spikelet or fascicle surrounded by an involucre of numerous bristles of unequal length, most of them 5–8 mm. long, one usually very much longer (1·2–2 or exceptionally to 4 cm. long), scabrid, one or several of the innermost and longest sparingly plumose towards the base, rarely all naked, often dark yellow, brownish or purplish towards the tips or blackish-purple from the base. Spikelets sessile or if in fascicles of 2–4, the lateral pedicelled, all lanceolate, more or less acuminate, 5–7 mm. long, glabrous, straw-coloured or tinged with brown or purple towards the tips of the florets, rarely blackish-purple all over, hermaphrodite or, if fascicled, the lateral male, rarely neuter or all hermaphrodite. Lower involucral glume suppressed or quite rudimentary, upper ovate to ovate-lanceolate, acute, 0·5–1, rarely to 2 mm. long, subhyaline, 1-nerved or nerveless. Lower floral glume male or more often barren, lanceolate, acute or acuminate, half as long to almost as long as the upper glume, 3-nerved, rarely 1- or 5-, or even 7-nerved, pale linear-lanceolate, 2-nerved, shorter than the glume or in the barren florets reduced or suppressed; upper hermaphrodite or in the lateral spikelets male, lanceolate, acuminate or rostrate-acuminate, scaberulous upwards, usually 5-nerved, pale narrow, linear-lanceolate, slightly shorter than the glume, tips minutely 2-toothed. Lodicules 0. Anthers 2·5-3 mm. long, tips very minutely penicillate. Styles united throughout; stigmas very slender, up to 4 mm. long, exserted from the top of the floret. Mature grain unknown.

A most variable plant as can be seen from Stapf's description given above. He refrains from subdividing the species.

Popular Names: Elephant Grass, Napier's Fodder.

Locality: Imported into Bombay in 1915. Has been grown at several centres in W. India: Agricultural College Farm, Poona, the Governor's Dairy Farm, Ganeshkhind, the Sewage Effluent Farm at Hadapsar in the Deccan, the Chharodi Cattle Farm in N. Gujarat, and the Willingdon Cattle Farm near Karachi.

Distribution: Indigenous in tropical Africa between 10° N. Lat. and 20° S. Lat.

Uses: One of the best fodder-grasses. See Stapf Kew Bull. (1912), 313–316; H. H. Mann in Bull. 100 and 127 of the Dept. Agriculture, Bombay; Rhodesian Agric. Journ. vii (1910), 1398.

(*To be continued*)

OLD DECCAN DAYS

BY

BRIGADIER-GENERAL R. G. BURTON

There has been more change in life in India in the last thirty or forty years than in the hundred years before. At any rate when I joined my regiment at a remote station in the Deccan forty years ago, the little cantonment was exactly as it had been since the Force to which I belonged was first reorganized under British officers in 1813. I say British officers, for such were the commandants, but there were at first French, Spanish, and what are now called Anglo-Indians as well, including many who held their commissions only from the Ruler of the State. But this had been changed thirty years or so before I joined, and we all belonged to the Indian Staff Corps. A battalion had only four or five British officers, a system under which the efficiency of the native officers was enhanced, for they had more independence and developed more self-reliance than in later years when the British establishment was more than doubled.

When I arrived in the early afternoon, a game of poker was being played in the mess. There was no bridge in those days, and probably more money changed hands. One player had recently won at a friend's house not only all his available cash but his moveable property, and had driven away with it in the loser's pony-trap, which was also part of the spoils. The mess was a long, low thatched building, cooled by a thermantidote and cus-cus tatties over the doors. On the walls hung the heads of bison and many fine sambar from the adjacent forests, and there was the mark of a bullet which had killed an officer who had passed safely through all the perils of the campaign in Central India in 1858, only to fall by the hand of an assassin in the following year. There hung also the skin of a fine tiger which had killed one of our officers a few years before. He was a good sportsman, and had met his fate in the usual manner in following a beast which he had wounded. The beast charged and seized him, while his sepoy orderly pluckily attacked and finished off the tiger with a spear, too late, however, to save his officer, who was mortally wounded, but was able to write a farewell letter before he died.

I occupied a small bungalow in which Meadows Taylor had written his famous book, *The Confessions of a Thug*, now perhaps forgotten, but which may be commended to the attention of those who would understand at least one frightful evil from which British rule has delivered the country. Even yet there were Thugs in confinement, and indeed some robbers of the kind at large. For one of our native officers, proceeding across country to his home with the savings of many years' faithful service, was brutally murdered and

robbed. There was also a gang of dacoits under the famous Tantia Bhil infesting the forests on the banks of the Tapti, in pursuit of whom our police officer was constantly out with his men.

Coming from the arid deserts of the Punjab, I rejoiced in the cool fresh breezes which blew from the hills and across the plains at the end of July. The cantonment was more than thirty miles from the railway, quite a short distance in those days, compared with others at which I served later from eighty to a hundred miles from the line of rail. I well remember my delight, when driving along the road in a tonga drawn by a pair of ponies, at seeing herds of antelope in the wheat and jowari fields, and sometimes a few, led by a buck with head thrown back and horns lying along his flanks, bounding across the road in front of us.

At last I saw the India of my dreams, and in imagination I peopled the distant forest-clad hills with tigers and other wild beasts; had I not said, from the time when I could first walk, that I would go to India to shoot tigers? And now at last there was some prospect of those early dreams being realized. For the forests abounded with wild life.

Alas! seen through the vista of forty long years, how far off and yet how near those days seem now! in a corner of my library stands the old rifle, and on the bookshelf lie the maps which were my constant companions for so many years. I used to ride out sixteen miles to the edge of the forest, where my men would meet me with gun and rifle. Then we would traverse another sixteen miles, this time of forest-road, and always find by the roadside a kakar, or four-horned antelope, or peafowl and junglefowl whose sonorous voices even now come ringing down the vale of years. Sometimes I saw on this road the pugs of a fine tiger, which was said to lie in wait and take bullocks out of passing carts. But I never saw him. There were many tigers but they were not as numerous as I found them a few years later in another part of the Deccan. Bears there were in plenty, and I shot more than one on the breezy plateau where there were scanty trees, long grass, and black boulders amid which these animals were not as conspicuous as they are in some surroundings. Here herds of bison or solitary bulls wandered almost unmolested, while the sambar bore the finest antlers to be found anywhere.

In the course of several visits to this forest, where I used to roam for a fortnight at a time. I saw only two tigers. One I failed to bag more from bad management than bad luck. It killed one of my buffaloes not far from my tent in broad daylight, and when it gave me a chance of a chest shot, I waited a moment too long in hopes of a shot at the flank, and so lost the opportunity for ever. The other was a tigress wounded in the evening by the Forest Officer. We took a pad-elephant and followed her up next morning. There were plentiful blood tracks, and under a tree a patch of blood and a piece of bone which had worked out of her shoulder, showing where she had lain down during the night. She had been hit on the point of the shoulder by a ·577 express bullet, which had not penetrated as it should have done, and the wounded beast had gone on into long grass and dense cover. The elephant was sent round with a

man and a supply of stones on her back, and when he had thrown a few of these the tigress charged out with a succession of coughing roars, sprang on to the elephant's head, and, having a broken arm, was shaken off, while the elephant, trumpeting loudly, crashed off through the forest. But the gallant tigress pursued and sprang on to the retreating elephant's hindquarters, only to be kicked off, when a shot in the flank sent her back to cover. Here we soon found her in an exhausted condition, and she was easily finished off.

Bears were at times aggressive and dangerous. One charged out at me at four o'clock one morning when I was riding along a forest path through the shadows and the moonlight, but he was off again with a gruff roar without charging home, and before I had time to take a shot. Another with a cub charged and was killed at close quarters; and three more, a family party, also made an unprovoked attack, the third making off when his companions were killed with a right and left. Probably the dense cover caused these aggressive acts, for the bears were surprised and alarmed suddenly at close quarters. One bear was said to be especially fierce, and had killed or wounded several harmless wood-cutters. I think this one was killed after being mortally wounded in an encounter with a tiger, for the villagers showed me the skin which bore many marks of tooth and claw; they had heard the sounds of the battle, and had finished off the bear by casting stones, just as biblical martyrs were slain. Another bear met with a very ignominious end. An old woman, looking over the steep side of a hill, perceived bruin sleeping beneath. She rolled a large rock over the precipice with such sure aim that life was crushed out of the unfortunate bear.

There have been several instances recorded of bears being killed by tigers, and on a hilltop I once found the remains of two which had thus met their end. The tiger must have been hard up for food, but he is not particular in his diet when put to it. Porcupine quills are often found imbedded in their paws, and I once found a number stuck in the back of a tiger. But then, a porcupine is no doubt a succulent morsel, fit even for human food. But how seldom seen by daylight! I once saw one at the entrance to his den at early dawn when I was stalking bison, otherwise these nocturnals have always evaded my notice. One killed a goat which I had tied up for a panther. A quill had pierced the heart, and the porcupine must have backed onto its victim, although my shikari said the fatal dart had been fired like an arrow from a bow! Then tigers will eat snakes, fish, and crabs when they can get nothing better.

Panthers were common in the forest. I shot one which sat up unafraid by the roadside when I was marching with my baggage carts just ahead of me, and quite a concourse of attendants were talking. The panther sat on his haunches eighty yards off and was killed by a lucky shot through the head. He was a poor starved looking specimen, although he had lately devoured a lungoor whose remains were in the stomach. His mate a few days later entered my camp and drank at a trough not far from my bed, and the following night fed sumptuously on a goat while I slept peacefully in a tree above, too exhausted with the day's exertions to keep a proper vigil. A bear also entered this camp, and I ran after it bare-footed,

but failed to get a shot, as the animal passed in an instant from bright moonlight into blackest shadow.

There were some bison near this camp. I went along the forest road before dawn one morning, and just as it was beginning to get light, I saw what I took to be an immense solitary bull standing by the roadside facing me. I walked up to it and fired into its chest, dropping it with a second shot as it bolted. At the sound of the shot a whole herd broke from the trees and thundered off, a young bull falling to a shot which left no mark upon the skin. Next morning I went to look at the carcases, and found a crowd of vultures and two or three adjutant birds gathered to the feast. Then a pack of lungoors gave tongue not far off, and on running to the spot I met a large bear coming up the hill from a ravine, and killed him with two or three shots.

I killed a wild dog near this same camp, and saw one day a pack of twenty or more of these destructive animals. The one I shot through the body with a rook rifle ran off as if unhurt, but I had heard the thud of the bullet and knew he would not go far. A hundred yards off I came up with him, and smelt him at some distance. For he had shed onto his black tipped tail a strong ammoniac secretion which betrayed his presence. This exudation from a sub-caudal gland perhaps gave rise to the native story that these animals blind their victims by flicking poison into their eyes from their tails as they gallop alongside. I shot another of these dogs when it came down in the nearly morning to drink at a pool over which I had been watching all night for a panther. The same night a ratel came and swam about in the water, plainly seen in the bright moonlight. And in this jungle also I saw a lesser civet cat, which I believe to be a rare animal; but perhaps, like many other creatures, its apparent rarity is largely due to nocturnal habits.

Near here I met one day the late Mr. Fred Wright of the Police; he told me he had come upon a large pack of wild dogs which had treed a couple of panthers, and were jumping up at them. One of the panthers was shot and stuck in the fork of the tree, whereupon the dogs below licked up the blood that dripped from the dead animal. The other leapt down and made off, followed by the dogs. In another jungle my shikaris saw a pack in full cry after a panther which had killed one of my buffaloes, and which they had driven from the kill. So it is quite likely that there may be truth in the story of their attacking and even killing tigers. My bull terrier once pursued a tiger which fled in terror from the yapping dog!

I well recollect one hot weather encamping not far from a forest pool which contained the only water in the neighbourhood. To this all the wild animals of the surrounding jungle resorted, and here I saw daily sambar, barking-deer and little four-horned antelope come down to drink. Here to the nilgai gathered towards midday, the time when most antelope appear to drink. They came daily, and I also recognized the same sambar stags which were hornless in this month of May. These things gave me the impression that all animals drink daily when they can get water, and not only every fourth day or so, as some naturalists have averred of sambar and nilgai. Here too came monkeys which

approached the water sometimes with signs of fear and always of timidity, perhaps because two leopards were wont to drink in the evenings when the sun was low or had sunk behind the line of trees in the west. And there were fine peacocks with burnished tails leading their troops of hens, and jungle-fowl and little brightly marked jungle bush-quail. Then there were green pigeons in the great banyan tree overhead, where the little coppersmith hammered out his monotonous 'tonk' and the brain-fever bird shrieked with an ever-increasing crescendo of maddening notes. But all sounds seemed to cease and a hush fall upon the face of nature when the panther padded silently to the water's edge. The peafowl and jungle fowl scuttled away, the small deer disappeared like spectres in the shadows of the forest, and the monkeys alone, if they had not gone, disturbed the scene with objurgations on their enemy.

Not far from this spot I shot the finest specimen of a 4-horned antelope that I have seen, the frontal horns having a length of 2½ inches, and I also killed a fine barking-deer with antlers 6½ inches long above the pedicle. The 4-horned antelope have a better development of horn in this forest than elsewhere, and I shot several with well-developed anterior horns. In the Western Ghauts I think these are generally absent, or represented only by insignificant callosities. These animals are generally single or in pairs, but I have seen as many as four together. I often found them feeding on the fleshy blossoms of the mohwa tree, which are also freely resorted to by bears and other animals, not excepting the aborigines of the jungle. Near here, too, I shot a blue bull which had been badly clawed by a tiger. Tigers will sometimes attack bison, and at another camp the jungle men showed me the head of a fine bull which, they said, had been killed by a tiger after a desperate encounter. This was very probably true, for a friend of mine killed a tiger not long afterwards in a neighbouring valley ; it had one eye gouged out, and marks of other injuries. I found a few miles from here the remains of a cow bison which had been killed by a tiger. The tracks had been made when the ground was wet and marshy, and the pugs of the tiger galloping in pursuit of the stampeding herd could be plainly seen ; the remains of a vulture which had paid for its temerity and had been killed by a stroke of the mighty paw were also there. In another jungle a Gond told me he had seen an old solitary bull attacked by a tiger which got the bull by the throat, but was flung off and put to flight.

The range of hills on which the forest was spread for many hundred miles was crowned by several massive forts, now long abandoned, but the scene of stirring events in days gone by. Through the mountains were several passes, some guarded by forts, and one, which I visited in search of a reputed man-eating tiger, dominated by some ancient temples where, since the legendary days of the Buddha, saffron-clad priests who occupied these solitudes had offered up their orisons to the deities of jungle, stream, and rock-hewn shrine.

One of these forts was stormed by the gallant troops of the greatest of British soldiers, whc, ascending these mountains from the battles of the plains below, completed here the final discomfiture

of a formidable enemy. It was said that the garrison, most of whom were killed in a brave defence, had cast their treasure into the tanks in the fort; but we found nothing when these were drained forty years ago, which was eighty-five years after the event. Such stories of buried treasure cling round many a mountain stronghold. Has the treasure of Apa Sahib, the Raja of Nagpur, ever been discovered in the Mahadeo Hills?

Thirty years before I ranged these forests in pursuit of game, the rebel Tantia Topi had attempted to break through with a portion of his forces, intending to raise the standard of the Peshwa in the Deccan and Southern Mahratta country. He was the ablest accomplice of the Nana of Cawnpore, the adopted son of the Peshwa Baji Rao who had surrendered near the fort of Asirgarh in 1818. But a force of cavalry and infantry came up with these rebels in the depths of the forest, and dispersed them with heavy loss of men and baggage. Since then, except for the presence of such bandits as Tantia Bhil, peace has reigned in the land.

There was sport to be had in the plains also. Vast herds of antelope, numbering some hundreds, roamed the fields in the fertile Berar valley. One might have shot hundreds, and the game-book of a forest officer showed over a thousand killed in the space of sixteen years. It was, however, poor sport to shoot these beautiful creatures, and must be still less sport in these days of long-ranging and accurate weapons. The little gazelle which inhabited the foothills were better worth pursuing, for they were more wild and offered a smaller mark. There, too, one had the chance of nobler game. I shot several panthers in the lower hills, and one sportsman was so fortunate as to kill a fine tiger which unexpectedly walked out in a beat. Then there were wolves, bustard, hares, and many kinds of feathered game, and even the rare hunting leopard might be met with, for I saw the skins of three shot in the forest, and one in the low hills.

In this part of the country man-eaters were rare, perhaps because game was plentiful, and wild animals and numerous flocks of domesticated cattle furnished an ample supply of food for predaceous animals. I did once see a child brought into hospital with its throat torn open by a wolf, but this was an uncommon occurrence, not as frequent as in Oudh, where wolves were said not only to devour children, but to bring them up with their cubs like Romulus and Remus of old. I also killed an infamous man-eating panther far down in the plains, where it found shelter in the rugged and jungly banks of a stream, and at night wandered round the hamlets in search of human prey. In the hot weather the family would be asleep on the threshold of the hut, for the sake of the cool air in that sultry clime.

Tired out with the day's labours the husbandman and his wife and little child are buried in deep sleep, lying side by side. It is dark; there is no moon, or if it shines its effulgence is hidden by a fleeting cloud. Night watches sphinx-like, starred with eyes, can other eyes not see? None save those burning orbs which gleam like glow-worms in the gloom. Padding silently on velvet footfall, the monster approaches; a rapid rush, a gurgling cry; the mother awakes

and misses her child. The village is aroused, lamps flash and they follow on the track but faintly seen. But the Watcher by the Threshold crouches silent with its prey, and in the morning nothing is found but a few blood-stained rags, and perhaps two little hands with yellow palms upturned as if in mute appeal for vengeance. Such are the details of many a village tragedy where the country is haunted by one of these monsters. I waited for this panther one night in the shadow of a hut in one of the villages which it was in the habit of visiting, and wounded but failed to recover it. It was finished off in the neighbourhood by the villagers a few days later.

In the Deccan, man-eating tigers are scarce. During many months spent in jungles infested by tigers, and during several years, I came across and killed only one man-eater; the incident had no particularly interesting features. Tigers seldom attack human beings unless molested, but it is probable that panthers are always ready to take a child. Tigers were numerous in the valleys of the Pein Gunga and Wardha River. They preyed principally on cattle, as game was comparatively scarce in country where native shikaris in the hot weather constructed an ambush and lay in wait over every water-hole. With their primitive weapons in those days they hesitated to attack so formidable a beast as a tiger, or even a panther. But in the reserved forests on the banks of the rivers there was an abundance of spotted deer and other beasts on which the tigers preyed. My best bag during a six weeks' trip in those jungles was fourteen tigers, besides some panthers, bears, and other game; another season I brought thirteen tigers to bag.

I have only once seen an unwounded tiger attack a man, but one that I shot had killed a herdsman who attempted to drive it off his flock; the body was not eaten. I have seen wounded panthers on several occasions attack with the utmost ferocity, and have myself been seized and mauled in such an encounter. But I once almost trod on a panther lying under a bush, where its presence was betrayed by the smell of wild beast, and it slunk off with no aggressive demonstration. I shot more than twenty of these animals in that particular district, where they lived in scattered jungle on the hill-sides and in the ravines, from which they were driven by beaters without difficulty. They preyed largely on antelope, with calves, goats and dogs for a change of diet.

Mention has been made of the historic interest not only of the hills but of the plains. In 1803 General Wellesley at the head of a small army, after a forced march with his cavalry to Poona, crossed the Godavery at Toka, where he established a ferry of coracles made of the willow-like *sambalu* and covered with skins, and entered Aurangabad. From thence, after a series of manœuvres and some hard marching to protect the Southern Deccan from invading Mahrattas, he at length encountered them on the field, 5,000 against 40,000 men or more, and defeated them after a bloody battle, in which he lost some 25 per cent of his men. Later he came up with them in December on the plain of Argaum, a little village picturesquely surrounded by betel gardens and shady groves of bananas, oranges, and other trees, and finally defeated and drove them from the field, an example of the superiority of discipline over numbers.

It was around Argaum that I found eighty-five years afterwards great herds of antelope, which ravaged the wheat and other cultivation in which they wandered at will. There might be five or six hundred of these animals in sight at once, and it is to be hoped that they have now been thinned down for the sake of the cultivator. In another part of the country, not far distant from Assaye, I found the antelope devastating the crops only sixteen years ago, and shot more of them than that I cared to from a sporting point of view. They generally had poor horns. Horns twenty inches long were above the average in the Deccan, and the longest I have seen were only twenty-four inches in length. These were carried by a brown buck, which presumably would never have a black coat, for he was an old animal. He had a leg broken by a shot, and was ridden down and speared after a long run.

The Deccan was infested by Thugs before they were discovered and extirpated mainly by the efforts of Sir William Sleeman. Travelling must have been very unsafe in those days, when the Thugs would waylay or accompany a whole party of travellers, who would be strangled in a moment and rapidly buried in graves already dug for them by a party sent on ahead for the purpose. This organized murder had been practised for generations, probably for the best part of a thousand years, and its suppression was alone enough justification for the establishment of efficient English rule throughout the country. Nor was this the sole evil of that nature whose suppression was due to the same cause. Those who would revert to the old order of things must be singularly ignorant of the history of their country. In the Deccan evidence of the insecurity of life and property in bygone times is everywhere to be seen. Every village contains a fort, sometimes with a rusty gun resting on the tottering battlements or lying in the rank herbage that springs beneath. Little more than a hundred years ago the country was ravaged by hordes of Pindaris who, issuing from their strongholds in the jungles and fastnesses of the Narbada, ravaged the country far and wide, robbing, torturing, and slaughtering the inhabitants, who found safety only behind the walls of the village fort. But now the husbandman tills his fields in peace, and the forts, no longer required under the establishment of a beneficent rule, are crumbling into dust. After a campaign in which great armies took part, the last of the Pindari chiefs, Chithu, wandering a lonely fugitive on the banks of the Tapti near Asirgarh, was killed and devoured by a man-eating tiger, his head alone remaining as evidence of his fate.

There used to be plenty of feathered game in the Deccan. In the cold weather we had good duck and snipe shooting on the numerous tanks, and the migratory quail assembled in the cotton and pulse fields in their thousands. Sandgrouse gathered at about nine o'clock in the morning at favoured drinking places, so punctually that one might almost set one's watch on the approach of the first bird. Partridges, painted and grey, were often numerous, and there were a few florican. These were said to have been at one time numerous, but an ignorance of their habits and the absence of game-laws had led to their destruction in the breeding-season, when the

'jumping' cocks betrayed the presence of the birds. Parties of sportsmen used to drag the long grass in which the birds were found with long ropes to which bells were attached, and so all the birds were flushed and shot down out of season.

Then there were peafowl and junglefowl. The peafowl were not half tame and sacred as in some parts of the country, but were among the most wary of birds, difficult to approach and to be shot only when driven out by beaters, or at long range with a rifle. Perhaps there is now more game than ever in the jungles and plains of the Deccan, but the old cantonments are forever silent where they used to resound with the tramp of horse, foot, and artillery. The Pax Britannica has enabled garrisons to be dispensed with.

Finally I would like to call to mind those who have otherwise passed beyond recall—my skilful and wise Bhil shikari Bhima; Kamaji, honest and keen, who lived on the bank of the Pein Gunga; old Nathu, bravest and most faithful of followers, who served me as shikari during many years; my good sepoys Shaikh Karim and Rajaram; and little Ram Chander, the police orderly, honest, trustworthy, truthful, and most devoted of attendants. One, indeed, still lives, of whom I have news not infrequently, the gallant Subadar Major who accompanied me on many an expedition. O, brave and faithful followers, now gone to the Happy Hunting Grounds! When the time comes for me to cross to the camp pitched on the far bank of the dark river, may you be there with news of the sport to be had in those Elysian fields!

THE STUDY OF PLANT LIFE

BY

CHARLES McCANN,

Asst. Curator, Bombay Natural History Society

PART II

(*With three plates and four text figures*)

(*Continued from page 703 of Volume XXXII*)

THE STEM

What is the stem? The popular term is restricted to those parts of a plant which grow above the surface of the soil, but popular terms are not always explicit nor correct. We have observed that roots may also rise above the ground; and is not a tuber an example of an underground stem? Botanically speaking, the stem is that part of the plant which bears the branches, leaves, flowers and fruit. This definition is, on the whole, satisfactory.

Stems display even a greater variety of shapes than roots. Some are much like roots not only in form, but also in their mode of growth. Good instances of these are afforded us by the underground stems known as *Rhizomes*, *Tubers*, *Bulbs* and *Corms* which shall be described presently.

UNDERGROUND STEMS

Stems may be underground stems, surface stems or aërial stems, but innumerable intermediate forms are to be met with, hence it should be understood that classification on these lines cannot be definite.

The Rhizome.—Rhizomes or Root-stocks are subterranean horizontally growing stems which give off leaves and flowering shoots on their upper surface and roots below. By means of such underground stems perennial plants are enabled to persist through the dry and winter season. The fern is a good example of a plant which exhibits a rhizomatous stem; the root-stock or rhizome of a fern is usually scarred on its upper surface with depressions which

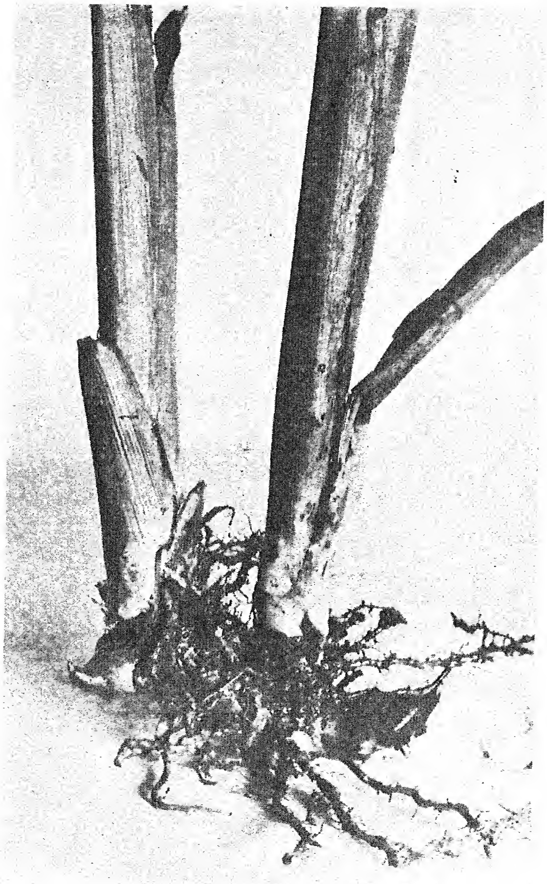
are the marks left by the old leaves; on closer examination it will be found that its surface is covered with small, sometimes scarcely visible scales known as 'scale-leaves'—in certain species these scales leaves may be quite large and readily distinguishable; their purpose is mainly protective. One end of the rhizome is however bare and devoid of these leaf scales—this is known as the 'vegetative cone' and is the growing end of the rhizome from which new shoots are developed. These features enable us to distinguish a rhizome from a true root. Most rhizomes produce numerous roots, but when this is not the case, the rhizome itself functions as such. The growth of a rhizome proceeds as explained only from one end—the vegetative cone, and as the growth proceeds the older portions usually shrivel and die away in course of time. Growth proceeds by increase in length of the vegetative cone or growing point, but occasionally the rhizome throws out branches. The new leaves are always borne by the forward extremity; the older ones dying away leaving scars on the upper side. It is often possible to tell the age of the plant by the old scars, in the case of plants which send up new vegetative shoots each year. In the struggle for existence which is eternally waged between plants inhabiting the soil, the rhizome plays an important role as it helps to establish the vigorous growth of a particular species contesting every inch of ground sometimes even to the exclusion of other species. In ephiphytic ferns the rhizomes are clearly visible wending their way up the stems of the trees and the rocks they grow on.

It must be remembered that this type of stem is not restricted to ferns alone but is also possessed by many other flowering plants, such as, Cannas and other members of that family (Plate III). It is by this mode of growth that some of our sea-shore plants are able to hold the sand together as the radiating extensions of the rhizome helps to bind it. Rhizomes exhibit a great variation of form and character but the general principles of growth remain the same.

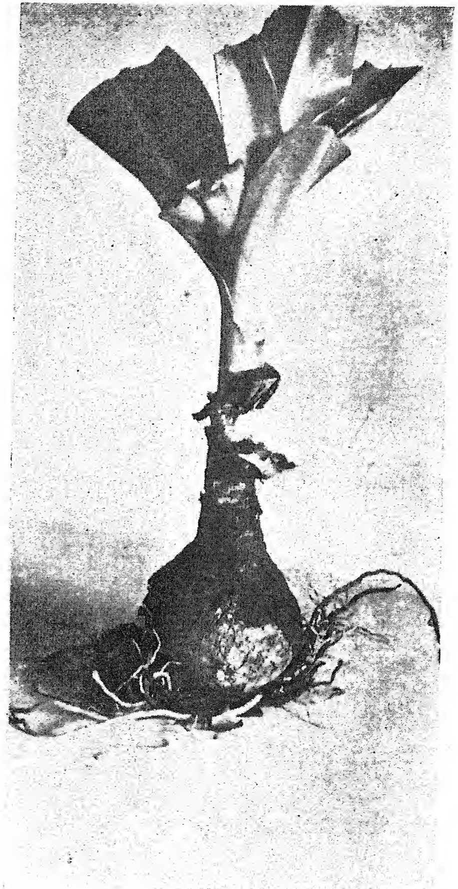
Tubers.—Tubers are readily studied in the Potato-plant (*Solanum tuberosum*). A potato is a true stem and the so called 'eyes' are individually capable of producing new plants. If any section of a potato bearing an 'eye' were planted in the soil it would give rise to a new plant capable of carrying on a separate existence. It is by this method potatoes are planted and propagated. The Jerusalem Artichoke (*Helianthus tuberosus*) and the Chinese Yam (*Dioscorea batatas*) are other familiar examples of tubers.

Bulb.—A Bulb is a subterranean stem not unlike a bud, with thick fleshy scales folded round a conical axis. It consists of a small disc-like stem at the base, bearing a more or less spherical mass of leaves folded one over the other and charged with reserve food and water. The onion serves an excellent illustration of a bulb. These leaves in an onion completely enwrap the bulb, which is then described as *tunicate*, while in the lily (Plate III) they merely overlap one another and the bulb is then said to be *scaly*. The outermost leaves of a tunicate bulb, as may be seen in the onion, are usually membranous and dry protecting the fleshy ones inside. In the centre of the bulb the disc-like base is prolonged into the short

A CORM
(*Amorphophallus campanulatus*)



A RHIZOME
(Canna)



A BULB OF A LILY
(*Crinium asiaticum*)

inflorence—axis or the central axis from which the flowering shoot is developed. Adventitious roots are developed from the disc.

Corm.—A corm or 'solid bulb' is not unlike a bulb but its scales are much thinner, fewer and more membranous than those of a bulb (Plate III). Crocuses, *Gloriosa superba* the beautiful creeper with spidery orange and scarlet flowers which flourishes during the monsoon, and those weird and sinister looking plants known popularly as 'Cobra Lilies' are some common examples of plants which afford illustrations for the study of this type of stem. The lower part of a corm is swollen out, at or below the level of the soil into a more or less spherical shape to contain reserve nutriment. At the top of this swollen mass is the vegetative bud which in the rainy season sends forth flowers and leaves. The period of activity of a corm which gives rise to such annual plants as flourish for a brief season is limited to a year but provision is made for next year's growth by new corms which arise as branches from the top or the side of the parent corm. The corm may however be perennial in which case a new leafy shoot arises each year from its upper surface, usually in the axil of a leaf of the preceding year.

Like certain roots some underground stems become specially modified to act as reservoirs and store-houses of reserve food materials and water and help the plant to tide over a season of drought or supply it with nourishment during the resting period. This explains how many plants in desert regions are able to maintain life through extensive periods of extreme drought. During the vegetative or active period of growth large supplies of reserve are laid by for the next season when the reserve is largely drawn upon at the time of flowering. Should flowering, however, be prevented, a very considerable saving in food reserves is the result. Bulbs of plants which are so treated gain considerably in size during the period of vegetative activity while the reserve of food is continually added to the corresponding drain on food stocks which would have been occasioned normally in the production of flowers. Hence bulbous plants which have their buds destroyed or cut out year after year just before the flowering period, amass an abnormal quantity of food material and when the plant is ultimately allowed to flower, it does so with redoubled energy and produces an exceptionally grand show of blooms. It is in most cases due to this fact that we have the exceptional size and beauty of 'florists' flowers.'

The conservation of food supply over long intervals explains the intense activity of desert plants in the production of flowers and fruit in a remarkably short interval of time. Numbers of bulbous plants grow in the most arid regions where they are subjected to protracted periods of drought. Buried deep within the soil, they are protected from the scorching rays of the sun until the return of the rains when they spring into intense activity and carpet the desert surface with a mantle of green verdure and bright blooms. The period of respite when moisture is abundant gives most desert plants the brief opportunity to flower and fruit and provide the sources from which when times are again propitious a new generation may spring. The flowering and fruiting period is

incredibly short and often a few weeks after where there was once a profusion of leaf and flower there is not a blade to be seen.

The same phenomenon has been observed in the frigid regions of the north where the brief springtide affords the occasion for the intensely profuse and rapid flowering and fruiting of many plants which for the rest of the year lie dormant beneath the snows.

To residents in India the change in the country wrought within a few days of the burst of the monsoon is remarkable. The ground is hard and bone dry. In areas covered by deciduous forest one tramps through a crackling carpet of dead leaves. With the first showers the whole aspect of the scene is changed; small flowers spring up through the rain-soaked soil and dapple the ground in clusters of white or various coloured blooms,—gradually the carpet is spread—the grass begins to sprout, but before it has grown very high these flowers have become fruit and the little plants that bore them are in full leaf till finally they are submerged in the tangle of grass and rank vegetation. Many types of bulbs, corms and rhizomes have been described as wanderers inasmuch as they change their original location. At one season a plant may appear in one spot and at the next a little distance away from the spot it originally occupied and thus appear to travel. This change of locality is brought about by subterranean stems sending out annually 'sucker-like' shoots for a certain distance which are fed by the parent. The parent then very often dies, its nourishment having been drawn out by the new shoots. These shoots then live separate existences.

A second instance is seen with gradual upward growth of a corm which rises by successive stages from deep below the soil up to its surface whence it may be transferred by extraneous causes to a new location. The Cobra Lily may be cited as an example. The corm of this lily (it must be remembered that the Cobra Lily is not a true lily) produces a new corm each year—the new corm is developed from the upper surface of the old one, it is nourished by the leaves and in addition draws the remaining nourishment from the parent corm which shrivels up and dies. Thus year by year the development of new corms bring each succeeding corm nearer the surface of the soil, till at last ground level is reached. The exposed position of the corm now renders it liable to be transferred from its original location through the agency of any animal or bird. When conditions are once more favourable for growth, the corm from its new location sends out a root deep below the surface of the soil. The food material within it is then transferred through the root to feed a fresh corm which develops at its extremity. The parent corm on the surface dies while from the new corm below the soil fresh corms develop in successive stages till ground level is once again reached and so the cycle is repeated. The exposure of corms on the surface of the soil is also brought about by the rains washing away the earth from beneath them and in this way the water also transports corms and bulbs, from their original locality.

Some corms when they near the surface of the soil give rise to numerous smaller ones which may be separated from the parent corm and transferred to various localities by the same agents where

they will repeat the process already described and thus give rise to many new individuals. Though new corms are formed yearly it should be understood that they begin existence as distinct individuals and derive their nourishment from their dead parents.

Yet even greater motion is exhibited by some of the plants which produce runners or *stolons* as they are technically known, such as the Strawberry-plant (*Fragaria*) and the Violet (*Viola*). The strawberry sends out runners or stolons in lateral directions under the surface of the soil from the fore ends of which new

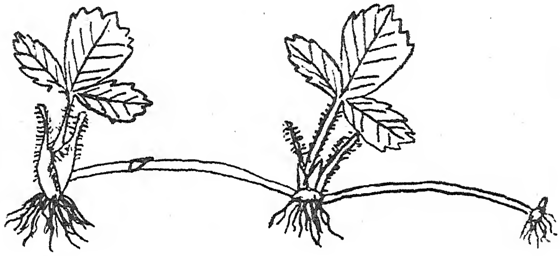


FIG. 1.

individuals arise (Fig. 1). In the case of climbing plants movement may be indicated by a change in the direction of growth occasioned by the necessity of finding a support. An urge of this nature will compel a climbing plant to cover enormous distances along the ground. This change in the direction of growth is known as *circumnutation*.

Aërial Stems.—Stems which grow above the soil are known as aërial stems; they display a much greater variety of form than those which grow beneath the soil.

They may be errect, prostrate, climbing and so on. All the palms, with the exception of a few species, have a simple, erect, unbranched stem which is termed a *caudex*, (Plate I) while other woody trees and shrubs have numerous branches. A stem that is not woody but weak, fleshy and often straggling and which dies down to the root periodically is said to be *herbaceous*. Again we have root-like or knotted stems, climbing stems and trailing stems. All these assume a great diversity of form—cylindric, triangular, quadrangular, ribbed, compressed, etc. For examples of the upright forms we have not far to look, for the majority of trees and shrubs about us afford instances of this type. Even those with the various climbing stems may be found within our gardens.

Plants with climbing stems may be divided into four different groups, (1) Twining plants, (2) Climbers with sensitive organs, (3) Hook-climbers, and lastly (4) Root-climbers.

Twining Plants.—The stems of twining plants climb by winding themselves round supports, which must not be too thick nor very smooth and must stand more or less upright otherwise climbing cannot be effected. Twining plants have long thin stems, the joints or nodes from which the leaves originate are widely separated, showing considerable areas of bare stem. The growing end of the

climber swings about freely in the air till it fastens itself around its support. A twining plant does not ascend directly but climbs in a spiral. The direction of the spiral may be clock-wise, i.e., *dextrorse*, namely in the direction of the hands of a clock, or may be counter-clockwise or *sinistrorse* that is to say from right to left. With a few exceptions plants of the same species will invariably follow the same direction in climbing. 'It is a matter of indifference to the direction of these movements,' says Kerner, 'whether we allow light, warmth or humidity to operate on this side or that; the particular species always twists in the same direction, the Hop towards the right, the Convolvulus towards the left. More than this, even if the twining portion is continuously bound in an opposite direction, the result is all the same; the plant cannot be coerced into any other path and will not depart from the direction peculiar to it. It continues to twist and twine according to an innate tendency inherited from generations of twisting to internal causes, to the peculiar constitution of the living protoplasm in each particular plant.'

A common example of a sinistral twining plant is the Railway Runner which is so commonly planted, and other members of the Convolvulus type. Most of the annual climbers which appear during the rains are also Twining climbers.

Climbers with sensitive organs.—A good example of this type is the Grape-vine which possesses thin thread-like organs which gradually respond to the touch of any object they come in contact with in their search for a hold. These organs are known as *Tendrils*; they are sensitive throughout their length so that if a contact is made at any given point of the tendril its free end will bend and twine round its new support and commence to climb higher in a continuous quest for a more abundant supply of light. Tendrils are modifications of various parts of a plant. They may be formed either from the leaf or parts of a leaf or by the modification of a branch. Some tendrils have adhesive discs or suckers at their tips by means of which they adhere to their supports.

Hook-climbers sprawl over other vegetation and have hooks, as their name implies, usually recurved which aid in their support. These hooks are not sensitive to contact like tendrils. An example of a hook-climber is the Common Cane (*Calamus*) of which there are many species to be met with in the dense evergreen jungles of India. In this case the hooks are arranged along a special elongation of the mid-rib of the leaf to form a whip or *flagellum* which either grows over some other branch and fixes itself there by means of the recurved hooks on its underside or hangs downward. Most people who have tramped through forest tracts where the climbing cane is abundant will have recollection of the too frequent and irritating halts occasioned by the necessity of freeing their clothes or their persons from the attachment of the all pervading cane which by its nature forms a very effective bar to impetuous progress and fully earns its popular name of 'Wait-a-bit'.

Root-climbers climb by the aid of special adventitious roots upon their stems. The Ivy, Peppers and others afford examples of this type of climber. These roots are not usually sensitive to gravity

that is they are not attracted earthward but follow all the crannies and irregularities of the surface on which they grow and thus firmly affix themselves to it.

The stems of climbing plants are very thin when compared with the great length they attain. Growth in girth is comparatively slow and is sacrificed to the more urgent demands of supplying the new leaves and the growing tips with the necessary water. Tropical climbers display remarkable and varied shapes in process of growth—flat, twisted, corrugated and so on. Climbers which attain a large size are known as *Lianas* (Plate II). Lianas are very common in all tropical forests and their wonderful size and growth have attracted the attention of all travellers from time immemorial.

Many climbing plants attain a great length, for they ascend the highest trees and sprawl over the tree tops in their efforts to get the requisite amount of sunlight. This wandering over the tree tops may however be checked by some great gap between trees which forms a barrier to the extension of the climber. The impetuous, ever-present urge of growth will then drive the creeper to descend earthwards again and continue its progress over the ground till it reaches the trunk of some other tree; which it ascends climbing higher and still higher till it attains once again a region of more abundant air and light. In its upward ascent by the creeping and pulling action of its growth such a creeper will sometimes draw the trailing portion of its stem clear off the ground or, in its downward descent, the free hanging end of the climber may be blown by the wind across the intervening gap and thus obtain a purchase on some fresh support. Thus are brought into being those festoons and giant rope-like suspension bridges which form such a characteristic feature and strike such a fantastic and primeval note in tropical forests. In process of growth and in their constant quest for light and for a place in the sun, many of these woody climbers grow to enormous lengths, some of them attaining several hundreds of feet or yards. Climbing plants in process of growth may crush or even kill trees which their mighty stems have clasped in a strangle hold, yet on the other hand many a forest giant uprooted in the fury of a storm is arrested in its fall by the kindly embrace of these amazing cables of nature—though uprooted, with its great trunk leaning forward ready to crash, the tree is saved from its fall by the climber's network of ropes twined about its branches. Before long many of the displaced roots refix themselves firmly in the earth, and the disabled giant receives a fresh lease of life or often a strong new shoot will sprout out perpendicularly from near the roots of the reclining trunk and in time become a stately tree.

Buttress stems.—Certain trees, many of them species which attain a great height, throw out wall-like projections in the form of buttresses from the lower portions of the trunk which serve the purpose of additional support. These buttresses are often of considerable height and may project for several feet so as to afford ample space for a comfortable hut to be constructed in one of the angles formed by them. In the tropical forests of Central America

buttress trees attain great size though not a few of our Indian trees have equally large buttresses.

Apart from the buttresses we may have other modifications of the the stem as in Pao-Barringudos (*Chorisia ventricosa*) of Brazil whose huge trunk bulges out in the centre like an enormous barrel. The bottle-trees of tropical Australia have much the same weird shape. In India we have the Baobab or Monkey-bread-fruit tree (*Adansonia digitata*), (Plate I) a native of tropical Africa with its enormous trunk. This plant was introduced into India and is now frequently seen about villages and towns. The enormous bole of the tree when hollowed out makes an excellent reservoir for the temporary storage of water which is kept cool and sweet within its depth. It is used as such by some of the tribes inhabiting the arid regions of Northern Africa.

Plants are divided into three main groups, *herbs*, *shrubs* and *trees* according to their type of stem—these definitions like most others are very vague, for there are no hard-and-fast rules for determining whether a plant is a herb or otherwise. In the majority of cases the popular recognition of a shrub, tree or herb is more or less correct. Plants of comparatively small size with soft, fleshy stems are rightly called herbs and may be divided into perennial herbs, annual herbs, etc., according to the length of their existence. Shrubs and trees are all perennial and have woody stems and branches. The term shrub is generally used to define a woody plant which does not grow to a great height, some authors placing the maximum between twenty and thirty feet. Shrubs are much branched often to the level of the ground. A tree on the other hand rises clear from the ground and does not commence to branch till the stem has attained a certain height. But the line of distinction cannot be drawn too finely as there are many plants which exhibit both characteristics, much depending on soil characters and climatic conditions. The same may also be said in relation to the size which distinguish shrubs from herbs.

Climate and soil conditions tend to modify or increase the size of plants even of the same species. In most tropical climates trees reach enormous proportions and gigantic heights, but as we advance towards the temperate regions they become smaller, till finally at the poles we have mere dwarfs. Altitude produces the same conditions, an ascent from the lower to the higher levels of a mountain range would display parallel changes in the character of the plant life. Frequently trees of the same genus are giants in the tropics when compared with their near relatives in colder climes which may be but a few inches in height. The Willow family supplies us with good examples.

The *Culm* presents another variation of the stem. The point at which the leaves originate from the stem of a plant is called the *node*—the space between two nodes is described as the *internode* (Fig 2). Now the stem of a plant whose nodes are separated by long hollow internodes is spoken of as a culm. All grasses present this type of stem and the bamboo which is itself an enormous grass offers an excellent example of it. Where the internodes are not quite hollow but pithy as in the canes, the stem is described by the term

1. Unbranched stems of Palms (*Caudex*).

3. Armed stem of Silk-cotton tree (*Bombax malabaricum*).

4. Stem of forest climber or liana (*Entada scandens*).

calamus. A further variation in type is seen in the stem of Cacti (*Opuntias*) and the Spurges (*Euphorbia*). The latter plant which is a common feature of the Indian countryside, is often erroneously spoken of as the Cactus. The true Cactus is not indigenous to India but is a native of America—though many species have been introduced into the country, the commonest of which the Common Cactus or Prickly Pear (*Opuntia elator*), has almost become a pest. The flat pear-shaped and leafless stems of the Cactus covered with fine needle like spines at once distinguishes it from the Spurge with its round, angular and twisted stem covered with sturdy prickles. The stems of both these plants act as water reservoirs in time of drought fitting them for an existence in waterless tracts. Besides being reservoirs, these stems perform for the plant those functions necessary to its existence which under ordinary circumstances are carried on by the leaves. We shall refer to them again when dealing with the leaves. The stems of a Cactus or a Spurge are called *Cladodes* or *Phylloclades*.

The stem of a plant is provided with an outer covering which is designed to resist the inclemencies of the weather and the attacks of animals. This protective layer may be smooth and of the finest texture as in herbs, or it may be intensely hard and rough and reinforced with coatings of hair, spines or thorns (Plate II). In addition to this external armature, the exudation of sap which flows from the stem when its outer covering is pricked or damaged also serves as a protective device inasmuch as it helps to effectively seal the injury or serves as a deterrent to animals that might otherwise feed on the plant.

As with other parts of a plant provision must be made for the stem to 'breathe.' In the case of the herb the outer covering of the stem is provided with 'breathing' pores similar to those we shall meet when we come to the study of the leaves, but in the case of trees and shrubs which are protected with a sturdy air-tight and water-tight coating of a layer of bark, provision for 'breathing' is solved by a simple and beautiful device which performs its function effectively. On the surface of the bark particularly along the branches one may find tiny erruptive craters which are the stem's 'breathing pores' known as *Lenticels.*

Branches.—The majority of plant stems are branched—the branches arising from the stem to bear the flowers and leaves. Certain stems such as the majority of the palms and other monocotyledons possess, are unbranched.

Branches are outgrowths from the main stem, which is known as the primary axis. These branches in turn give rise to other branches from the axils of leaves; these again develop a third series, to which will succeed a fourth, fifth and so on, thus forming the complicated branching system of our large trees. The term branch is commonly restricted to the large divisions, whereas the smaller ones are referred to as twigs. The larger branches are frequently called *boughs.*

Stems and Branches unlike roots produce dissimilar members i.e. leaves, flowers, etc. while roots produce like members. One feature is however common to both roots and branches in the course

of development. Branches in both cases arise in *acropetal succession*, that is to say, the new branches normally arise near the growing apex so that the youngest are always nearest the tips.

Branches like roots may originate at any part of the stem in which case they are known as *adventitious branches.* As a general rule, however, the point of emergence of a branch is governed by the position of the leaves. Where the stalk of a leaf joins the stem or, to be more exact, in the angle made by the leaf-stalk with the stem, one finds a tender protuberance or bud—this is known as the *axillary bud* while the angle between the leaf-stalk and the stem is called the *axil.* (Fig. 3). These tiny protuberances are the budding branches;

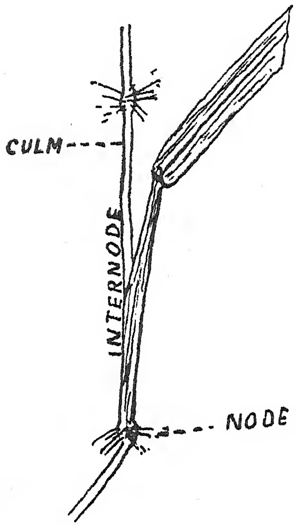


FIG. 2.

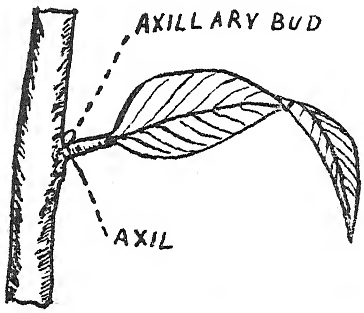


FIG. 3.

they are the tiny shoots which will later develop into branches. Should two or more branches arise in the same axil they are termed *accessory buds.* The manner of their origin is also indicated by distinguishing terms. When accessory branches emerge side by side they are said to be *collateral*, but if they originate one above the other they are described as *serial.* Bearing in mind the separate origin of a branch and a leaf we are able to decide the correct nature of tendrils, spines and such organs of a plant as are structural modifications of its leaves—a tendril growing from the axil of a leaf would be a modified branch, but on the other hand, if its origin is traceable to the leaf-stalk we know that it is a modification of the leaf.

A plant may have branches of two kinds—long and short shoots or shoots of unlimited and limited growth. The former grow indefinitely whereas the latter remain short, often resembling tufts of leaves. The Casuarina, a familiar tree along our coasts, is an example of the short-shoot type.

Buds (of branches) developed at the growing extremity of a stem do not always sprout at once. In the case of most trees these buds remain inactive until such time as they are excited to growth either by the death or injury of one of the other buds. Such buds are said to be *dormant buds*. Dormant buds are more frequently found among plants inhabiting places that experience marked changes in the seasons. Hence they are rarely in evidence in tropical plants. Thus in places where the winter is severe and accompanied by snow the .majority of trees may be said to hibernate. They shed their leaves in the autumn and the growing tips of their branches become dormant. These growing tips are generally covered by a growth of hairs, scales, etc., or by the secretion of resins which protect the sensitive tips from the rigours of the winter season till the approach of spring once more rouses the dormant buds to activity.

Branches that arise later in life upon the lower parts of the trunks are occasionally formed from dormant buds but they are more often adventitious, being developed from new buds formed without relation to the leaves.

As stated previously, the main stem of a tree is known as the primary axis—its branches are lateral outgrowths from the main stem. The development of branches in trees conforms to two distinct types. If we take a pine tree for example we note that the tree increases in height by the direct and uninterrupted growth of the main stem, so that the apex of the stem forms the highest point of the tree. The branches are merely lateral and horizontal extensions of the main stem and tend in no way to increase its height. This type of branching is distinguished by the term *monopodium*. The mango tree, to take a common example, illustrates the second and totally distinct type of branching distinguished by the term *sympodium*. The branches of the tree overtop or form a crown above the axis or main stem of the tree. In process of growth the mango sprouts from its seed as a tender shoot which increases in height till it tends to branch. The main branches arise from buds given off laterally at the apex of the stem. To explain the process in more detail, two buds are generally given off on each side of the growing apex. One of these buds in course of its development grows upwards as a continuation of the main stem or axis while the other may be suppressed or pushed aside by the development of the branch and tends to form a lateral branch. The process is repeated on alternate sides as the stem grows. By this process of continuous branching it is therefore actually made up of portions of branches which have originated from different growing points. There are many variations of these two main types of branching to be met with which cannot however be dealt with in the course of the present article.

At times branches assume most remarkable and misleading characters. The curious leaf-like expansions of the Butcher's Broom (*Ruscus aculeatus*) (Plate) frequently cultivated in gardens are in reality the flattened branches or *cladodes* on the surface of which the little greenish flower is borne. Another common plant is a species of *Phyllanthus* also to be met with in gardens, which has flattened leaf-like branches bearing the flowers.

Arrested branches frequently develop into hard points known as *Thorns.* In some trees these thorns are simple whereas in others they are branched. The modified branches occasionally bear leaves which is surely a true indication of their nature. Thorns of this nature are commonly met with on the species of *Flacourtia* found on the Ghats, the vernacular names of which are *Atak* and *Ataram.*

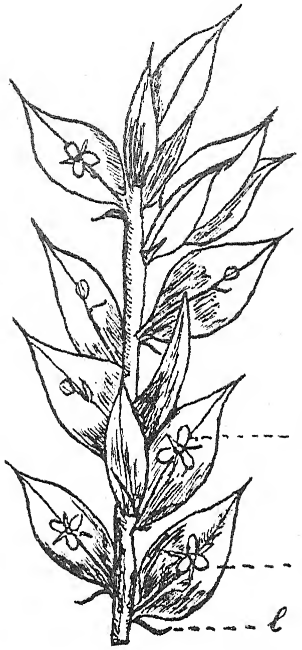


FIG. 4.

f = FLOWER, *c* = CLADODE, *l* = LEAF.

Thorns and spines often are an effective armature in so much as that they ward off would-be enemies, such as browsing animals, and thus protect the tree against extermination. Though it is commonly believed that such devices are developed to protect the species, scientists have not arrived at any satisfactory explanation for their presence.

Plants in arid regions are stunted, woody and frequently covered with spines. These thorns and spines are said to be the result of scarcity of moisture and scorching winds which tend to kill the branches before they have time to develop. Plants in deserts often become one mass of hard short branches arrested by the above agents and by browsing animals, and are frequently covered with thorns to be able to protect the few flowers and seeds which develop under these circumstances very often on the innermost branches. Even the leaves of these plants areoften greatly reduced in size.

In the next part of this article the leaves of plants will be dealt with and more will be seen with regard to their nature—the various shapes they assume together with their many and varied modifications.

(*To be continued*)

INDIAN DRAGONFLIES

BY

F. C. FRASER, Lt.-Col., I.M.S., F.E.S.

Part XXXI

(*With three plates*)

(*Continued from page 691 of Vol. XXXII*)

Subfamily—Epallaginæ

Head robust, transversely elongate; eyes globular, large, much more widely separated than in the *Libellaginae*; labium with mid-lobe cleft nearly to its middle, apices of lobes subacute; labrum oval, very broadly and very shallowly notched; occiput rounded at the middle, tumid behind eyes, broad; frons depressed; epistome ridged, not projecting markedly.

Prothorax with a large rounded boss on each side the middle lobe, posterior lobe moderately large, transversely elongate, simple, rounded.

Thorax robust, short, shoulders broadly rounded, nearly always bearing two pairs of stripes (except in adult males where these are obscured by melanism), one pair of stripes formed by confluence of antehumeral and humeral above and below, the other by a similar confluence of a post-humeral and a lateral.

Legs comparatively short, hind femora extending to middle of 2nd abdominal segment, furnished with very fine spines; tibial spines slightly more robust; claw-hooks inconspicuous, situated near apex of claws.

Wings hyaline or enfumed in the female, hyaline or with one or both pairs coloured in the male, the hind often bearing large metallic spots or areas; forewings long and narrow; hindwings similar or more or less dilated in the male, shorter than the abdomen in the male, as long as, or slightly longer than the abdomen in the female, shortly or not at all petiolated; reticulation very close, cells mainly tetragonal; *Rii* at its origin not in contact with *R + M*; node nearer base of wing than apex or situate at its centre; *Riv + v* arising from *Rii* at about the level of outer end of discoidal cell; *IRiii* separating from *Rii* at about halfway from arc to node; basal space entire, about twice the length of discoidal cell which is very short, straight narrow, squared at the ends, with parallel sides, longer in the hindwing than in the fore, entire or traversed by one or more nervures; arc slightly angulated; sectors of arc arising from about middle of arc; *IA* strongly curved especially at origin, several rows of cells between it and hinder border of wing; *Cuii* straight; many supplementary nervures between all main sectors; antenodal and postnodal nervures very numerous; primary antenodal nervures entirely absent; no incomplete basal antenodal nervures; the first and second series of antenodal nervures coinciding as in the *Libellulinae* with occasional exceptions. Pterostigma present in all wings of both sexes, very long and narrow, tapering at both ends which are oblique.

Abdomen long narrow cylindrical, longer than the wings in the male, of the same length or shorter in the female, the 10th segment flat on dorsum or with a robust carinal spine or two spines.

Anal appendages very similar, the superiors forcipate, spatulate, large, at least as long as 10th abdominal segment; inferiors very small and inconspicuous or moderately large, always shorter than superiors.

Genitalia. See under genera.

Females remarkably homogeneous in size, colouring and general facies, so that where several genera or species exist together, it is difficult to determine which are the respective pairs. Abdomen in all species marked laterally with a yellow or pale blue stripe which broadens at the base of each segment and tapers apicad, becoming gradually lost as traced towards the anal end of abdomen.

Anal appendages as long as segment 10, tapered, very acute.

Vulvar scale robust, made up of a laminated sheath with two small stilette-like organs which act as tactile organs at end of ovipositor.

Distribution. Southern Asia from Western India and Ceylon to China and the Philippines and southwards to Borneo, Java, etc. One genus has spread westwards into Europe *via* Kashmir and Persia.

The subfamily is represented by nine genera,—*Epallage*, *Anisopleura*, *Bayadera*, *Dysphaea*, *Allophaea*, *Mesophaea*, *Indophaea*, *Pseudophaea*, and *Paraphaea*. The whole of the genera save *Mesophaea* and *Paraphaea* have representatives within Indian limits, the former including *ornata* and *decorata* from Indo-China, both of which have the hindwing of the same peculiar shape as seen in *Thaumatoneura inopinata* from South America, whilst the latter has but a single species,—*barbata* from the Philippines.

From the similarity of the known females of these genera, it is obvious that the primitive males must have resembled the females, and that specialization has gone on in them only. It is for this reason that our genera are founded solely on male characters, it would indeed be quite impossible to split up the subfamily effectively otherwise. The old genus *Pseudophaea* is here split up into four genera, as apart from similarity in basic venation, the differences in colouring, petiolation and shape of wings are so broad as impossible to be reconciled. Selys in his classification split up the genus into groups and these again into subgroups; it is to the original groups that generic rank has been given, a procedure which I very much doubt any odontologist will quarrel with.

In determining the precedence of these new as well as old genera, the closeness of the similarity of the male to the female has been taken as the measure of archaicism, thus it is evident that a species like *ochracea* in which the fore and hind-wings are similarly shaped and of similar shape to those of the female, is much nearer the root ancestry of the subfamily than one like *variegata* where specialization in the male, has led to such divergence from the female, that an entomologist ignorant of the order, might well be excused in determining them as different species.

Out of the 24 known species I have been able to study 16, viz.—*dispar*, *cardinalis*, *fraseri*, *impar inæquipar*, *tricolor*, *subnodalis*, *subcostalis*, *ornata*, *decorata*, *ochracea*, *brunnea*, *splendens*, *refulgens*, *variegata* and *masoni*, which, together with author's descriptions, have formed the basis of the following key :—

Key to Genera of the *Epallaginae males*

1.	Discoidal cell entire	2
	Discoidal cell traversed	4
2.	Costa of hindwing of male running straight from base to node	3
	Costa of hindwing of male with an obtuse projecting angle between base and node ...	*Anisopleura* Selys.
3.	Abdomen of male longer than wings; node situated slightly proximad of centre of wing; wings petiolated to level of first antenodal nervure	*Bayadera* Selys.
	Abdomen of male shorter than wings; node situated at centre of wings; petiolation almost absent, ending well proximad of first antenodal nervure	*Epallage* Charp.
4.	Tenth abdominal segment without a carinal spine	*Dysphaea* Selys.
	Tenth abdominal segment with two dorsal spines	*Paraphaea* Mart.
	Tenth abdominal segment with a dorsal spine...	5
5.	Fore- and hind-wings similarly shaped, saffronated in part but without any opaque areas ...	*Allophaea* gen. nov.
	Fore- and hind-wings differently shaped, the hind at least with some opaque markings ...	6

6. Both fore- and hind-wings more or less opaque black, the hind markedly broader than the fore and usually bearing a large basal metallic blue or green area ... ... *Pseudophaea* Kirby.
Only the hindwings partly opaque black ... 7

7. Hindwings with the middle part abruptly broadened the apical portion thereafter narrowing rapidly to a falcate apex ; the broadened portion bearing an opaque band ... ... *Mesophaea* gen. nov.
Hindwings usually much shorter than the fore and markedly rounded at apex, the apical half or less opaque black and sometimes bearing a brilliant metallic blue spot ; abdomen in some species bright red, otherwise black ... *Indophaea* gen. nov.

Genus—Epallage Charp. (1840)

Epallage Charp. Lib. Eur. p. 16 (1840) ; Selys, Rev. Odon. p. 143 (1850) ; Id. Syn. Cal. p. 49 (1853) ; Id. Mon. Cal. p. 162 (1854) ; Walk. List. Neur. Ins. B.M. iv. p. 636 (1853) ; Kirby, Cat. Odon. p. 108 (1890).

Characters as for the subfamily ; wings of both sexes hyaline or enfumed at apices, narrow, petiolation almost absent, ceasing well proximad of the 1st antenodal nervure ; hindwing not more broad than fore and of similar breadth in the two sexes ; *Rii* not in contact with *R + M* at its origin ; node situated at centre of wing ; discoidal cell entire, short, less than half the length of median space ; arc only slightly angulated ; only 1 cubital nervure in all wings (rarely 2) ; not more than 4 long intercalated nervures posterior to *IA* in the hindwing, and only 2 between *Cuii* and *IA* ; *Riii* in continuation with the subnode or a shade distad ; outermost antenodal nervure in all wings often incomplete ; no basal incomplete antenodal nervures in subcostal space ; pterostigma long and narrow.

Thorax very robust ; abdomen not or only just extending beyond tips of wings ; anal appendages longer than segment 10, the inferior only slightly shorter than the superiors and minutely bifid at apex, the superiors strongly hooked or angulated downwards at apex.

Genotype—*fatima* Charp :

Distribution—Greece, Turkey in Europe, Asia Minor. Persia, N.W. India and Kashmir. The species *alma* Selys, from Persia is probably not more than a local race or variety, so that the genus contains but a single species. Unfortunately nothing has been recorded about its habits, and noting how widely those of the two allied genera, *Bayadera* and *Anisopleura* differ, it is idle to speculate by comparisons. All we know is that it breeds in streams.

Epallage fatima, Charp. (*Agrion fatima*) Lib. Eur. p. 132, t. 45, fig. 2 (1840) ; Selys (*Euphaea fatime*), Rev. Odon. p. 143 (1850) ; Walk. List. Neur. Ins. B.M. iv. p. 637 (1853) ; Schneid (*Euphaea fatime*) Stett. Ent. Zeit. vi. p, 115 (1845) ; Selys (*Epallage fatime*) Syn. Cal. p. 50 (1853) ; Id. Mon. Cal., p. 165 (1854) ; Id. Bull. Acad. Belg. (2) xxvii. p. 659 (1869) ; Id. ibid. (2) xlvii, p. 371 (1879) ; Id. (*Epallage alma*) ibid. (2) xlvii, p. 372 (1879) ; Kirby, Cat. Odon. p. 108 (1890) ; Morton, Trans, Ent. Soc. Lond., p. 305 (1907) ; Laid. Rec. Ind. Mus. vol. xiii, p. 40 (1917).

Male. Abdomen 28–32 mm. Hindwing 32 mm.

Head : labium yellow, base and apex black ; labrum olivaceous with a median basal black impression ; cheeks, bases of mandibles, anteclypeus and sides and foreborder of postclypeus pale olivaceous, rest of head black. Two rounded bosses on the frons ; occiput coated with rather long coarse yellow hairs. Eyes brown.

Prothorax black but a thin pulverulent covering making it to appear dark violet, especially the small posterior lobe. Laterally and subdorsally coated with long white hairs.

Thorax black, the sides and beneath markedly pulverulent, especially the latter which may be chalky white from pruinescence.

Legs short, hind femora not reaching the middle of 2nd abdominal segment when extended and the whole leg falling short of the distal end of 3rd segment ;

black, the femora pulverulent, the two hinder femora with a dorsal and a lateral yellow stripe throughout their length, from the latter of which spring a row of short widely-spaced black spines ; anterior pair of femora with only the dorsal stripe.

Wings hyaline, the apices narrowly bordered or tipped with dark brown ; pterostigma black ; 12 to 14 antenodals, 15 to 16 postnodals.

Abdomen black, the basal segments often pulverulent white.

Anal appendages black ; superiors as long as one and a half times the length of segment 10, seen from above widely separated at the bases and strongly divaricate, thick, tumid, with subacute apices, Seen from the side very robust, stout at base with the true apex turned strongly down and in, like the grappling flukes of an anchor. On the outer side, at a point where the apex is bent on body of appendage, a short stout hook directed down and outwards. Inferiors about two-thirds the length of superiors, conical, broad at base, the apex black and nipple-like, the basal portion light brown. On the upper side and near apex, a small spine giving the apex a bifid appearance.

Juvenile males closely resemble the colouring of the female. The frons yellow, black at its middle, with a rounded yellow spot on each side ; a small oval yellow spot on each side of the anterior ocellus, whilst the occiput has a transverse yellow band. Thorax with the middorsal crest, a curved humeral stripe, four oblique stripes on the sides, the 3rd being the broadest and the 4th the shortest, some spots at the roots of wings and two small spots on the ante-alar sinus all yellow. Abdomen with a vestigial middorsal stripe and a similar but better defined lateral, all tending to become obliterated towards the apical segments.

Female. Abdomen 28-32 mm. Hindwing 28 to 32 mm.

Similar to the juvenile male but with rather more yellow markings. The thoracic markings are especially clearly defined and bright yellow. The hind pair of femora are dark reddish brown with the yellow stripe broadening proximad. The lateral abdominal stripe is very broad and almost confluent with a narrow basal annule on each segment, whilst segment 1 is entirely yellow save for a small linear spot on each side running obliquely upwards and forwards.

Wings with apices much more broadly tipped with brown, whilst the bases are palely saffronated especially along the costal region as far as the node. Nodal index slightly higher than in the male.

Distribution. As for genus. I possess a female from the Amanus Mts. in Asia Minor and a couple of males from the Wadi Kelt, Palestine. Mr. Bainbrigge Fletcher, after extensive collecting in Kashmir, never came across this insect, although he took all other known Kashmir species.

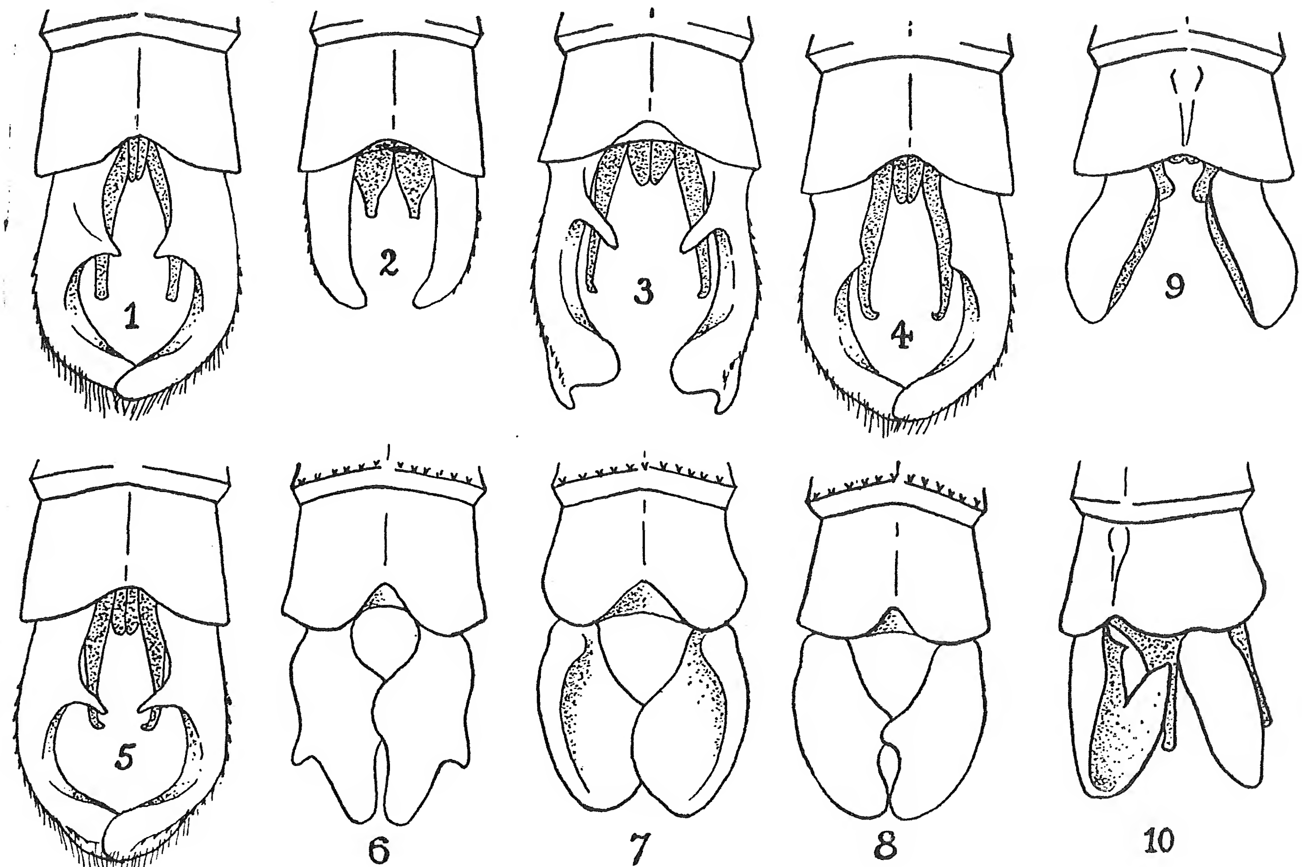
There is a male in the Paris Museum from Baghdad, and 2 females from Macedonia in the British Museum. Lastly the species was taken by Col. Nurse at Quetta (2 males in June).

Genus—BAYADERA Selys (1853)

Epallage group *bayadera* Selys, Syn Cal. p. 49 (1853) ; Id. Mon. Calop., p. 162 (1854) ; Walk. List., Neur. Ins. B. M. iv. p. 636 (1853) ; Selys, Bull. Acad. Belg. (2), xlvii, p. 373 (1879) ; Will. Proc. U.S. Nat. Mus , vol. xxviii, p. 169 (1904) ; Laid. Rec. Ind. Mus., vol. xiii, p. 24 (1917) ; Ris, Suppl. Ent. No. 1, pp. 48, 49 (1912).

Characters as for the subfamily ; wings of both sexes hyaline, the apices (of two species) tipped with black, narrow, the hind wing not more broad than the fore and of similar breadth in both sexes ; petiolation extending from about halfway from base to arc and to level of 1st antenodal nervure ; *Rii* in contact with $R+M$ at its origin and for some distance ; node situated at centre of wings ; discoidal cell entire, short, less than half the length of median space ; arc more angulated than in *Epallage* ; only 1 cubital nervure in all wings (the nervure *AC*) ; not more than 4 long intercalated nervures between *IA* and the posterior border of wing and only 2 long ones between *IA* and *Cuii* ; *Riii* not in line with the subnode, either a little proximad to or widely distad of (in *indica* and *hyalina* respectively) ; outermost nervure in all wings complete ; no basal incomplete antenodal nervures in subcostal space ; pterostigma long and narrow.

Thorax very robust ; abdomen longer, often much more so, than wings ; anal appendages considerably longer than segment 10, the superior forcipate, apices



DORSAL VIEW OF ANAL APPENDAGES OF

1. *Bayadera melanopteryx*, RIS.
2. ,, *brevicauda*, RIS.
3. ,, *indica*, SELYS.
4. ,, *longicauda*, SP. NOV.
5. ,, *hyalina*, SELYS.
6. *Anisopleura lestoides*, SELYS.
7. ,, *comes*, SELYS.
8. ,, *subplatystyla*, FRAS.
9. *Epallage fatima*, CHARP.
10. The same seen in semi-profile.

curling in and converging on one another, subcylindrical, apices obtuse or depressed, with or without a ventral basal spine ; inferiors conical, tapering to a fine point, much less robust than superiors.

Genotype—*indica* Selys.

Distribution. N. E. India, Upper Burma, S. China and Formosa. Only five species of this genus are known at present, of which *indica*, *hyalina* and *longicauda* are from within Indian limits and *melanopteryx* and *brevicauda* from S. China and Formosa respectively.

The species described by Dr. Ris from Formosa as *hyalina* is certainly not that species of which I possess examples from the type locality. The figure of the appendages given by Dr. Ris shows the superiors to be equal in length to segment 10 and without any sign of a ventral spine. In true *hyalina* there is a well marked spine and the appendages are much longer than segment 10, about twice the length in fact. I have therefore renamed the Formosan species as *brevicauda*. Below I describe another new species as *longicauda* in which the superior anal appendages are also of great length but the ventral spine vestigial, it also differs from *hyalina* by having the wings and abdomen nearly of the same length, the abdomen being markedly the longer in *hyalina*.

But little is known of their habits and the larva is unknown. The writer in company with Mr. Shaw of Moungpoo, British Sikkim, took a number of both sexes of *indica* in the bed of the Riyang River, from its source to near its entry into the Teesta. Its habits were strikingly similar to those of *Dysphaea* for which it was at first taken to be. The males perch on prominent rocks or twigs projecting from the water in mid-stream. Being very shy and wary, they were not at all easy to capture or even approach in such spots. This particular species looked remarkably like *Vestalis apicalis*, which however is never seen in such spots. It also perched with its abdomen slanting up at a sharp angle, as does *Dysphaea*. When disturbed, it moved down stream with a markedly flitting flight, soon coming to rest again. If repeatedly stalked, it would do a wide circle round its pursuer and return upstream again. Many pairs were seen in cop, a very unusual circumstance in the larger *Zygoptera*, and these pairs took long flights down stream seemingly looking for a suitable spot to deposit their eggs. None were actually seen in this process. The Riyang has a wide expanse, with sandy bottom strewn with numerous rocky boulders, so that one could walk down stream using the latter as stepping-stones in the stalking of the elusive insects. The larva is probably somewhat like that of *Anisopleura* described below. From a study of the habits, I am inclined to think this genus is closely related to *Dysphaea*.

Bayadera indica Selys. (*Epallage indica*) ll. cc. p. 49 (1853), p. 163 (1854) ; Walk. (*Euphaea indica*) l. c. p. 636 (1853) ; Ris, l.c. p. 49 (1912) ; Laid. l.c. p. 31 (1917) ; Mart. Mission Pavie, 3, *Neurop*, p. 15 (sep.) (1904).

Male. Abdomen 38 to 40 mm. Hindwing 34 mm.

Head : labium with middle lobe and base black, lateral lobes greenish yellow ; labrum, bases of mandibles and cheeks as far up as beyond the antennae turquoise blue, the edges of bases of mandibles and labrum finely black, as also a small median basal virgule on labrum ; rest of head matt black : eyes dark brown above, olivaceous below.

Prothorax black with a very large rounded spot on each side of midlobe and a smaller spot low down on each side of posterior lobe greenish yellow ; posterior lobe large, with rounded border, lappet-shaped.

Thorax black marked with bright greenish yellow as follows,—a fine antehumeral stripe curving out above and below, confluent below with a broad humeral stripe which covers the suture and nearly confluent with it again above so as to nearly shut in a broad oval black spot of the ground colour ; laterally three broad irregular stripes, one on each of the sutures and the third covering the greater part of metepimeron, all three broadly confluent above but the first and second partially separated by a short tongue of black on upper part of second lateral suture. Beneath prothorax and thorax pulverulent white, as also the middle lobe of labrum and basal segments of abdomen beneath.

Wings hyaline, apices of all blackish brown to about the middle of pterostigma which is black ; extreme base saffronated ; 23 to 24 antenodal nervures in forewings, 21 to 22 postnodals ; 18 to 19 antenodal nervures in hindwings, 19 to 21 postnodals ; *Riii* arises slightly proximad of the subnode.

Abdomen black with the middorsal carina finely yellow from segment 1 to 8 and with a narrow lateral stripe greenish yellow, broad on the sides of segmenst 1 and 2, narrow from 3 to 5, but broadening and confluent with an incomplete basal annule at the base of each segment; on segments 6 and 7 this line present as a mere basal vestige; 8 to 10 unmarked.

Anal appendages black, superiors broad at base, narrowing slightly at the middle, broadening and depressed at apices into a triangular plate which is hollowed out below, a robust ventral spine near the base directed somewhat inwards so as to be visible from above, whilst slightly basad of middle of appendages and on the inner side, a small tubercle almost amounting to a spine but blunt at apex. Inferior appendages slightly more than half the length of superiors, broad at base, tapering rapidly to a fine acute apex. Both pairs of appendages separated at base, the inferiors divaricate, the superiors parallel but the apices curling in and actually overlapping. Genitalia veiy similar to *fatima*.

Female. Abdomen 36 mm. Hindwing 37 mm.

The female does not appear to have been described nor do there appear to be any specimens of this sex in collections other than those taken by Mr. Inglis and myself.

It is a much more robust insect than the male, with shorter stouter abdomen and relatively longer wings. The latter without black apices, but the bases palely saffronated; nodal index rather higher, 24 to 25 ante-and post-nodal nervures to forewings, 22 of each to hind; pterostigma very long, black.

The body markings are exactly as in the male but the lateral stripe extends to the apical end of segment 7 on the abdomen. Legs black, hind femora with the proximal ends and a broad stripe on the sides greenish-yellow. Vulvar scale robust, extending to end of abdomen. Anal appendages nearly twice the length of segment 10, tapering to a very fine point.

Distribution. N.E. India, N. Bengal in the rivers about Darjeeling District. Dr. Ris states that he has a series from Shillong, Khasia Hills, Assam, but I cannot help thinking that this is an error and that *hyalina* is meant. Mr. Bainbrigge Fletcher who has collected almost exhaustively in this area has taken *hyalina* but never *indica*, the type of *hyalina* in the Selysian collection also comes from Shillong, whereas *indica* comes from Bengal. Its habits have already been commented on above. *B. indica* is distinguished from *hyalina* by its much larger size and by the apices of all wings in the male tipped with black. From *melanopteryx* it is easily distinguished by the much less extent of black on the wings, extending in the case of the latter, as far as 2 to 3 cells distad of the node, whilst from *brevicauda* and *longicauda* it is distinguished by the apices of all wings black.

Bayadera hyalina Selys, Bull. Acad. Belg. (2), xlvii, p. 373 (1879); Ris, l. c. pp. 49–52 (1912); Laid. l.c. p. 31 (1917); Ris. Suppl. Ent. No. v, p. 3 (1916).

Male. Abdomen 34 mm. Hindwing 29 mm.

Head: labium black, the lateral lobes greenish yellow at their bases only; labrum, bases of mandibles and cheeks turquoise blue, the former barely margined with black and without the median virgule present in *indica*; rest of head matt black.

Prothorax black with a very large greenish yellow spot on each side of the midlobe and a tiny spot on outer ends of the posterior lobe, which is similarly shaped to that of *indica*.

Thorax black marked with bright citron yellow as follows,—a fine antehumeral line not reaching upper end of dorsum and not confluent with the narrow humeral stripe either above or below. The humeral stripe much narrower than in *indica*; three narrow stripes on the sides, of which the two latter only are confluent above and that by a mere point. A broad bar of yellow beneath thorax of which the hinder area is broadly black. Legs black, unmarked.

Wings entirely hyaline; pterostigma dark brown, over 5 to 7 cells; 21 to 23 antenodal nervures to forewings, 20 to 21 postnodals; 17 antenodal nervures to hindwings, 20 to 21 postnodals. *Riii* begins 1 to 2 cells distad of the subnode.

Abdomen glossy black with a triangular spot of citron-yellow on the sides of segment 1, remaining segments unmarked.

Anal appendages black, superiors about twice the length of segment 10, moderately broad at base, tapering slightly to beyond the middle and then dilated slightly at apices but not nearly to the same extent as in *indica*. The

apices twisted on their longitudinal axis and flattened, not hollowed out below; a robust subventral spine near the base, not quite as long as in *indica*; no medial tubercle on inner side of appendages. Apices curled in towards each other. Inferior appendages broad at base, tapering rapidly to an acute point, not quite half the length of superiors.

Female. Abdomen and hindwing 33 mm.

Differing very slightly from the male but more robust in build and the abdomen of similar length to hindwings; the antehumeral stripe well defined and reaching upper end of dorsum but not confluent at either end with the humeral stripe. The third stripe at extreme end of metepimeron is confluent at a point with the second lateral stripe to form a hook-shaped marking. Beneath black with a mere suggestion of yellow at the centre; this surface largely pruinosed white. Abdomen with a lateral stripe on segments 1 to 4, broad at base of 3 and 4 and tapering to a fine point which falls slightly short of apical ends of segments; in addition a small round well-defined spot on each side of segment 10. Anal appendages conical acutely pointed, slightly longer than segment 10. Wings similar to male, nodal index similar.

Distribution. Assam. The type is from Shillong, Khasia Hills, Assam from where I have seen several examples. The species differs from *indica* and *melanopteryx* by the wings entirely hyaline, and from *brevicauda* and *longicauda* by having a well developed ventral spine to superior appendages, absent in the former, vestigial in the latter.

Bayadera longicauda sp. nov.

Male. Abdomen 38 mm. Hindwing 34 mm. (Female unknown.)

This new species is very closely allied to *hyalina* but differs in the following important particulars,-labium entirely black; labrum not margined with black; cheeks and labrum greenish-yellow this colour passing in above epistome to form an incomplete band across front of frons.

Prothorax with the posterior lobe entirely yellow save for a small crenulate black mark at base.

Thorax with the antehumeral stripes complete and curving out at upper ends, the remaining stripes narrow but the two hinder lateral ones broadly confluent at their upper ends; antealar sinus with 2 large greeny yellow spots. Abdomen almost unmarked, a small lateral spot on segment 1, a tiny vestige at the base on sides of 2 and a small triangular lateral basal spot on segments 3 to 5. Wings with 19 to 21 antenodal nervures in forewings, and 24 to 25 postnodals, 15 to 16 antenodals in hindwings, 20 to 25 postnodals. Pterostigma black, over 5 to 6 cells; *Riii* begins well distad of the subnode; all wings palely enfumed, especially the apices of hind.

Anal appendages very similar to those of *hyalina* in length and general shape but the ventral spine of superiors vestigial, amounting to no more than a pointed tubercle, and in addition a robust obtuse tubercle at the middle of upper and inner border. Inferior appendages very broad at base, shorter than in *hyalina*.

Distribution. British Sikkim, Gangtok, 5,000 to 6,000 ft. alt. A few specimens collected by Mr. Chas. Inglis, May 29, 1924. The shape of the appendages will readily distinguish this species from any others, as well as the relative lengths of abdomen and wing. A further striking feature is the bright yellow posterior lobe of prothorax which offers a very useful identification mark.

Genus.—ANISOPLEURA Selys (1853)

Anisopleura Selys, Syn. Cal. p. 48 (1853); Id. Mon, Cal. p. 158 (1854); Walk. List. Neur. Ins B. M. iv, p. 635 (1853); Kirby, Cat. Odon. p. 108 (1890); Will. Proc. U. S. Nat. Mus., vol. xxviii, p. 169 (1904); Laid. Rec. Ind. Mus., vol. xiii, pp. 24, 25.(1917).

Characters as for the subfamily; wings of both sexes hyaline or, at the most, with apices tipped with black in the male; petiolation as in *Bayadera* or extending a little distad of the basal antenodal nervure especially in the hindwing; all wings in both sexes narrow and of equal breadth; costal border of hindwing in male with an abrupt angulation outwards at a point about one-third the distance from base to node. the resulting widening of the costal space gradually decreasing from the angulation outwards; *Rii* not in contact with $R+M$ at its origin; node situated at about middle of wing; discoidal cell entire, equal to about one-third or a little less than half the length of the median

space in forewing, a little more than half as long in the hind; arc markedly angulated; sectors of arc widely separated at origin, far more so than in *Bayadera* or *Epallage*; from 1 to 5 cubital nervures in all wings (usually only 1 in *lestoides*, several in other species); *1A* distinctly forked, or if not, then with 3 to 4 moderately long intercalated sectors between itself and hinder margin of wing; only 2 long intercalated sectors between *1A* and *Cuii*; *Riii* widely distad of the subnode, about 1 cell more so than in *Bayadera*; outermost antenodal complete but normally not in alignment; no basal incomplete antenodal nervure in subcostal space; pterostigma long and narrow.

Thorax robust; abdomen always longer than the wings, long and cylindrical; anal appendages variable, the inferiors always more or less aborted, superiors subcylindrical or markedly spatulate, with or without a robust latero-ventral spine.

Genotype—*lestoides* Selys.

Distribution. Bengal, Sikkim, Assam and Upper Burma. The species of the genus breed in montane and submontane streams and I have found it breeding in irrigation channels running through tea plantations in Bengal. Unlike *Bayadera* it keeps to trees or bushes bordering the streams, the female retiring further back in the jungle and only visiting the stream when ovipositing, at which time it is always taken in cop with the male. Only occasionally does it descend to the river bed, but immediately retreats to vegetation on being disturbed. Its flight is short and flitting.

Anisopleura lestoides Selys, ll. cc. p. 48 (1853), p. 159 (1854); Walk. (*Euphaea lestoides*) l. c. p. 635 (1853); Kirby, Cat. Odon. p. 108 (1890); Selys, Ann. Mus. Civ. Genov. (2) x (xxx) p. 489 (1891); Laid. Rec. Ind. Mus, vol. xii, p. 31 (1917).

Male. Abdomen 36 to 38 mm. Hindwing 28 to 30 mm.

Head: labium black, pulverulent white at base; labrum greenish-yellow narrowly bordered with black; bases of mandibles, the cheeks broadly up to as far as level of lateral ocelli, and the postclypeus greenish-yellow; anteclypeus black; vertex and occiput black with a large rounded spot of greenish-yellow on the outer side of each lateral ocellus; eyes blackish brown above, olivaceous green below.

The dorsum of head sometimes pulverulent white.

Prothorax black with the outer ends of the posterior lobe and a very large lateral spot on the middle lobe greenish-yellow.

Thorax black marked with an antehumeral stripe, broad below, tapering above where it turns out as a short point; laterally the whole central part of metepimeron and a broad irregular stripe centred over the first lateral suture greenish-yellow, the dorsal black extending well beyond the humeral suture and a small tongue of black descending on the upper part of first lateral suture.

Legs short but robust, spines fine, black, a greenish stripe on the outer sides of the two hinder pair of femora, tapering towards but not extending as far as distal ends.

Wings hyaline, the forewings of male with the extreme apex dark brown, the bases palely saffronated; only one cubital nervure in all wings; *1A* not clearly forked; 15 to 19 antenodal nervures in forewings, 13 to 16 in the hind; 20 to 22 postnodal nervures in forewings, 17 to 18 in the hind; pterostigma black, over 3½ to 4½ cells; petiolation shorter than in other species, often arrested short of the first or basal antenodal nervure.

Abdomen black marked with greenish-yellow as follows,—the sides of segment one broadly, a broad lateral stripe on segment 2, a basal ring broadly interrupted on the middorsum and a narrow lateral stripe on segments 3 to 6, the stripes becoming shorter and confined to middle portions of segments 5 and 6; lastly the middorsal carina finely yellow from segments 3 to 6.

Anal appendages black; superiors subcylindrical at base, broadened and depressed near apices which curve in towards each other and even overlap; seen from above the upper border distinctly sinuous and curving down slightly at apex; at about the middle of each appendage and situated on its ventro-lateral face, a robust spine visible both from above and from the side, especially from the latter where the spine can be seen directed analwards; inferior appendages rudimentary, not visible in profile.

Very adult specimens show a marked pruinescence, especially beneath thorax, on the coloured part of prothorax and thorax, the temples and dorsum of last two abdominal segments.

Female. Abdomen 30 mm. Hindwing 29 mm.

Very similar to the male in markings but these rather more extensive especially on the abdomen which is short and very robust.

The lateral abdominal markings consist of a long stripe and basal spot narrowly separated and extending the whole length of segments 2 to 7, the spots being confluent on 2 where the stripe is very broad ; segment 8 has a small round apico-lateral spot and 9 a very large irregular lateral spot extending over more than half the segment ; segment 10 unmarked, very short, notched on dorsum. Anal appendages half as long again as segment 10, tapering to an acute point.

Vulvar scale robust, not quite reaching end of abdomen.

Distribution.— Bengal, Assam and Sikkim at altitudes of about 3,000 to 5,000 ft. On the wing from May to September.

Anisopleura comes, Selys, C.R. Soc. Ent. Belg. xxiii, p. lxiii (1880) ; Kirby. Cat. Odon. p. 108 (1890) ; Selys, Ann. Mus. Civ. Genov. (2) x (xxx), p. 489 (1891) ; Laid. Rec. Ind. Mus. vol xiii, p. 31 (1917).

Male. Abdomen 36 to 40 mm. Hindwing 29 to 34 mm.

Head : labium black, pruinosed at the base or whole of middle lobe ; labrum citron yellow finely margined with black ; anteclypeus black ; postclypeus, bases of mandibles, cheeks up as far as antennæ and a broad band across frons citron yellow ; rest of head matt black with a small oval spot of greenish-yellow on outer side of each lateral ocellus ; eyes black above, dark olivaceous beneath.

Prothorax black, the outer ends of posterior lobe and a very large triangular spot on each side of middle lobe citron yellow, these marks in adult specimens pruinosed white.

Thorax black with a very fine, often interrupted antehumeral line more or less confluent with a broad humeral fascia which extends up dorsum for about the lower two-thirds and broadens out markedly below ; laterally the greater part of sides, the postero-lateral suture marked out in black, and the metepimeron narrowly framed in same.

Legs black, the hind femora yellow on inner sides distally and often pruinosed white, as also the sides and beneath thorax.

Wings hyaline, the extreme apices of forewings of male dark brown ; pterostigma black, over $3\frac{1}{2}$ to 4 cells ; 3 to 4 cubital nervures in forewings, 4 to 5 in the hind ; *IA* often forked ; petiolation begins at level of or distal to level of the basal antenodal nervure.

Abdomen black marked similarly to *lestoides* ; segment 7 usually with a small latero-basal spot ; segments 9 and 10 chalky white with pruinescence.

Anal appendages black ; superiors seen from above, narrow at base, very broad and cupped above thereafter, usually overlapping so that the two appendages viewed from above form a triangle with a small window at the base. Seen from the side conical, tapering gradually to a subacute apex ; no latero-ventral spine. Inferior appendages even more aborted than in *lestoides*.

Female. Abdomen 32 to 33 mm. Hindwing 33 mm.

A stouter more robust insect than the male but marked very similarly ; the base of labrum often narrowly black ; the ends of posterior lobe of prothorax more broadly yellow ; the antehumeral stripe rarely interrupted and usually expanded in its upper portion ; the abdominal markings extending on to segment 8 and 9 and exactly similar to *lestoides* ; nodal index higher, 17 to 19 antenodal nervures in forewings, 20 to 23 postnodals ; 17 antenodals in the hindwings, 19 postnodals ; 3 to 6 cubital nervures in forewings, 3 to 7 in the hind ; pterostigma dark yellowish brown between black nervures.

Vulvar scale very robust, not extending quite to end of abdomen.

Distribution. Bengal, Sikkim, Assam and the Punjab Hills. It is a moderately common insect around Darjeeling at the lower levels from about 3,000 to 4,000 ft. from April to June. This species is easily distinguished from the last by the cubital nervures, the presence of a humeral stripe and the absence of a spine to the superior appendages and lastly by its much greater size. I found it breeding in irrigation channels in cinchona plantations at Moungpoo, Darjeeling District. The imago was quite numerous on herbage beside such courses but rose high into trees unless stalked warily.

Anisopleura furcata, Selys. Ann. Mus. Civ. Genov. (2) x (xxx), pp. 488, 489 (1891) ; Will Proc. U. S. Nat. Mus. vol. xxviii, p. 181, fig 13 (1904) ; Laid. l. c, p. 73 (1917).

Male. Abdomen 32 mm. Hindwing 27 mm.

Head : labium black ; labrum, postclypeus and corners of mandibles pale blue or greenish-yellow ; rest of head black save for a small rounded greenish-yellow spot on each side of ocellar space.

Prothorax black with a large rounded spot greenish-yellow occupying the sides and subdorsum of middle lobe.

Thorax black marked with a greenish-yellow antehumeral stripe broad below, tapering above ; laterally greenish-yellow, the metepimeron finely framed in black and the hinder lateral suture mapped out in black ; beneath black.

Wings hyaline, extreme bases palely saffronated ; extreme apices of forewings tipped with brownish black ; pterostigma brownish black. over about 4 cells ; 15 to 17 antenodal nervures to forewings, 21 to 22 postnodals ; 14 to 15 antenodals to hindwings, 18 to 19 postnodals.

Legs black, inner sides of hind pair of femora distally yellowish.

Abdomen black marked with citron yellow exactly as in *lestoides*, dorsum of segments 9 and 10 pruinosed white.

Anal appendages black, slightly longer than segment 10, subcylindrical, apices broadly obtuse and curving in slightly ; on the outer side a very robust spine equal in size to the apex of appendage, so that the latter appears to be forked from its middle, and seen in profile, resembles a crab's claw. Inferior appendages rudimentary.

Female. (Unknown).

Distribution.—Upper Burma. The type (as well as those of *lestoides* and *comes*) in the Selysian collection, is from Puepoli, taken in June. This species closely resembles *lestoides* in many respects, by its lack of a humeral stripe, by its venation, size, etc., but it may be distinguished by the greater size of the spine of superior appendages which gives a bifid or branched appearance to those structures. In *lestoides* the superior appendages broaden out markedly on the inner side as seen from above, quite different to what is seen in the present species.

Anisopleura subplatystyla, Fras, Rec. Ind, Mus. vol. xxix, p. 81 (1927).

Male. Abdomen 34 mm. Hindwing 28 mm.

Head : labium black, middle lobe pruinosed white ; labrum bright greenish-yellow finely margined with black ; cheeks, postclypeus, and a stripe across lower part of frons and bases of mandibles greenish-yellow ; rest of head matt black with a large reniform spot on the outer side of each lateral ocellus ; eyes dark brown.

Prothorax black with the outer ends of posterior lobe and a very large oval spot on each side of middle lobe greenish-yellow.

Thorax black marked with citron yellow as follows,—narrow antehumeral stripes running close to and parallel with the middorsal carina, the upper end of the stripes curved outward ; a narrow humeral stripe running parallel to the former and broadly confluent with it below but not above although the two approximate ; a small upper spot lying close to the outer side of the humeral stripe ; laterally broadly yellow, the metepimeron narrowly framed in black, and the second lateral suture mapped out in same. Beneath and lower parts of sides pruinosed white.

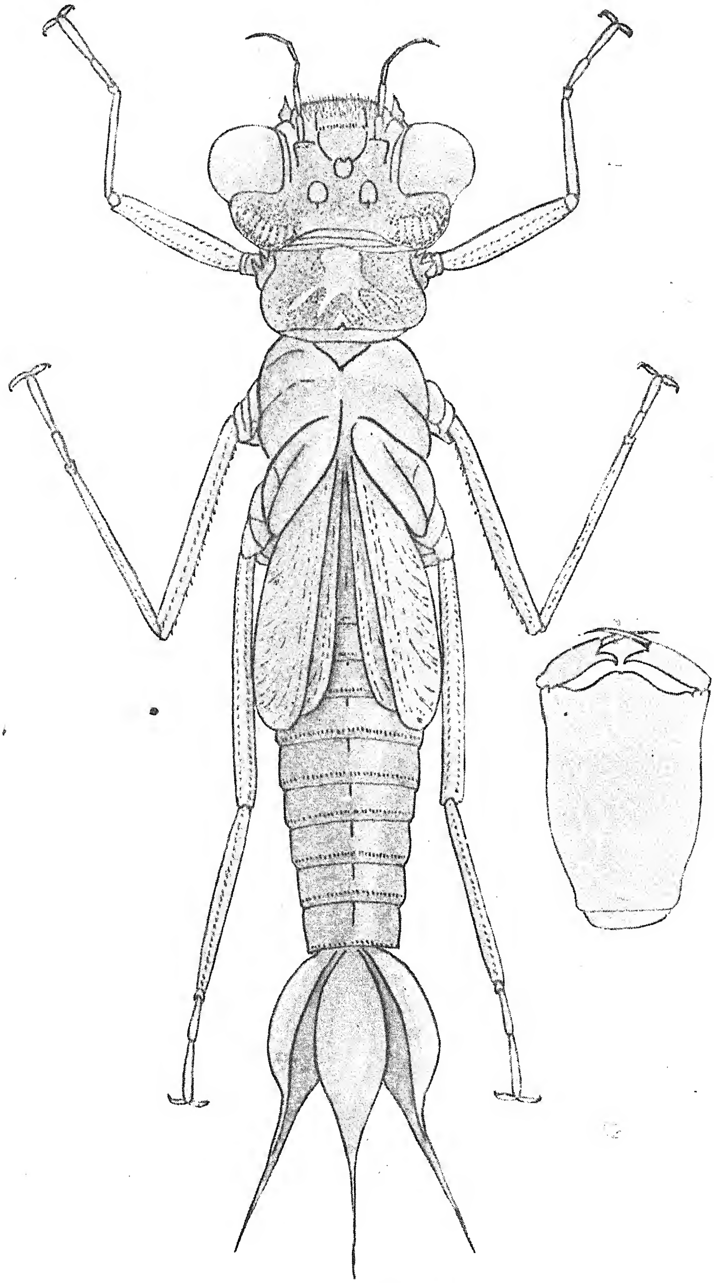
Legs black, outer and proximal portions of femora yellow, these parts pruinosed.

Wings hyaline, apices of forewings tipped with dark brown as in other species ; pterostigma dark blackish brown, over 4 cells ; 17 antenodal nervures to forewings, 22 postnodals ; 14 antenodals to hind, 20 postnodals ; 3 to 4 cubital nervures to forewings, 4 to 5 in the hind ; *Riii* well distad of subnode ; *IA* usually forked.

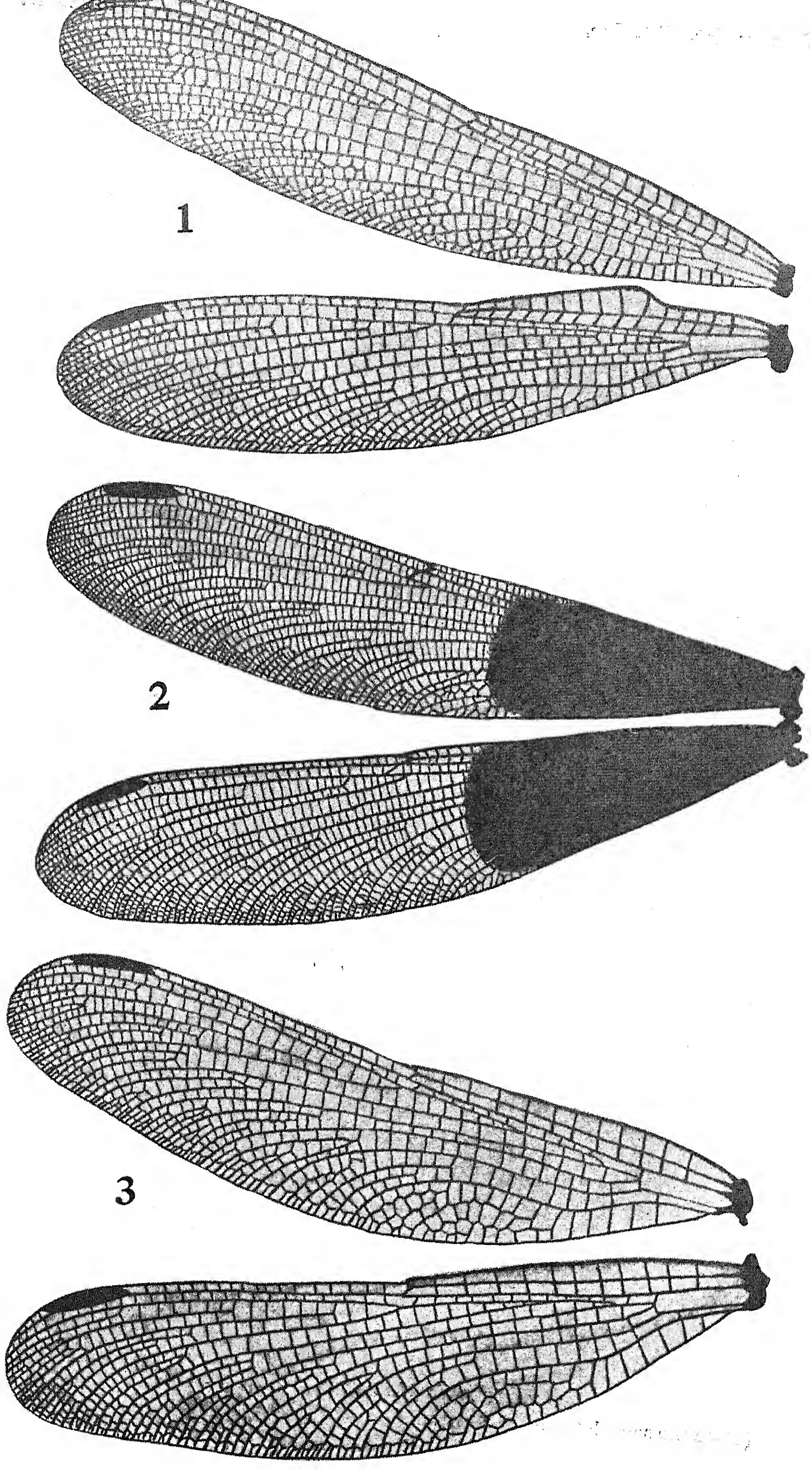
Abdomen black, segments 9 and 10 pruinosed white on dorsum, other segments marked as in *lestoides* as far as segment 6.

Anal appendages black, superiors very similar to those of *lestoides* but the spine replaced by a much smaller one not visible from above and situated nearer base of appendage. Inferior appendages rudimentary.

Female. Abdomen and hindwing 30 mm.



LARVA OF *Anisopleura subplatystyla*, FRAS.
(Note the sacculated caudal gills and total absence of ventral abdominal gills.)



1. Wings of *Anisopleura lestoides*, Selys, male.
2. ,, *Dysphæa walli*, Fras., male.
3. ,, *Epallage fatima*, Charp., male.

Closely similar to the male but stocky and more heavily built, markings very similar to the male, differs as follows,—the labrum with anterior border more broadly black and with its base broadly black; yellow band across frons nearly cut into two at the middle; posterior lobe more broadly yellow and an additional band of yellow forming a collar to the prothorax; the antehumeral and humeral bands confluent above as well as below and the upper humeral spot triangular instead of linear; trefoil-like spots on coxæ and six small spots on under surface of thorax; abdomen marked similarly to the female of *lestoides*; wings saffronated at bases and in subjuvenile examples, brightly so as far as the node in costal area, the subcosta and radius being also yellow for the same distance and often the whole of the nervures at base of wing to outer end of discoidal cell; nodal index slightly higher; cubital nervures 3 to 5 in all wings. Vulvar scale as for *lestoides*.

Distribution. Assam. A number taken in Shillong by Mr. T. Bainbrigge Fletcher who has kindly sent them to me for examination. Type at present in the Pusa collection, paratypes in my own. This species by its interesting combination of *comes* and *lestoides* characters, is easily distinguished from all others, thus it has the combined ante-humeral and humeral stripes and numerous cubital nervures seen in *comes*, whilst its appendages are more similar to those of *lestoides*.

Genus—DYSPHAEA Selys (1853).

Dysphaea Selys, Syn. Cal. p. 53 (1853); Id. Mon. Cal. p. 185 (1854); Walk. List. Neur Ins. B. M. iv, p. 641 (1853); Kirby, Cat. Odon. p. 110 (1890); Will. Proc. U. S. Nat. Mus. vol. xxviii, p. 169 (1904).

Characters as for the subfamily; wings of male usually marked with opaque black (except in *ethela*), hyaline in the female, apices rather pointed, narrow, the hindwing not noticeably broader than the fore and of equal breadth in the two sexes; *petiolation entirely absent; Rii* not in contact with R + M; node situated at or slightly distad of middle of wing; *discoidal cell traversed* at least once, short, about half or one-third as long again as the median space; arc almost straight; sectors of arc arising from middle of arc and well separated at origin; usually 3 cubital nervures to all wings, occasionally more in the hind; 4 or more intercalated nervures between *IA* and the posterior border of wing, *IA* very occasionally forked; only 2 intercalated sectors between *Cuii* and *IA*, rarely more; origin of *Riii* variable even in the same species, nearly always more distad in the hindwings, usually in continuation with or proximal to the subnode in the forewing, and in continuation with or distad to subnode in the hind; outermost antenodal nervure complete but often not coinciding with the subcostal half; no basal incomplete antenodal nervure in subcostal space; pterostigma present in all wings of both sexes, narrow long.

Thorax robust; legs as for subfamily; abdomen always extending to beyond tips of wings, often markedly so; anal appendages very homogeneous, simple, longer than segment 10, forcipate; segment 10 notched at its apical border, *its dorsum flat*, not raised into a keel-like spine as in all the following genera; vulvar scale robust, short, not reaching end of abdomen.

Genotype—*dimidiata* Selys.

Distribution. From Western India and Upper Burma to Malacca, Java, Sumatra, Borneo and New Guinea.

Species of the genus breed in swift montane and submontane streams, from 1,000 to 4,000 ft.; their habits, so far as known, are exactly similar to those of *Bayadera*. Shy retiring insects, the females are rarely seen, spending their time feeding up in the jungles not far from their parent streams, often perched high up in trees. The males will also take to such lofty roosting places during dull weather and at night—I have seen them perched on twigs at a height of forty feet from the ground, from which vantage point they would flit out and back again preying on passing flies. More often the males are found in the bed of the stream resting on rocks or twigs in the middle of the boiling waters and taking short flights, flitting in nature, out and back to the same resting place. Females have no generic characters separating them from those of the rest of the group, *Pseudophaea*, *Indophaea*, etc.

Dysphaea ethela. Fras. Rec. Ind. Mus. Vol. xxvi, pp. 480-482 (1924.)

Male. Abdomen 38 mm. Hindwing 33 mm.

Head : velvety black, unmarked save for two triangular marks below and hidden behind occiput yellow ; eyes dark brown above, pearly grey beneath.

Prothorax black with a dark ochreous rounded spot on each side of middle lobe.

Thorax velvety black marked with greenish-yellow often rather obscured,—fine antehumeral and humeral stripes confluent above, separated below but obscured or absent in fully adult specimens.

Laterally greenish-yellow shaded with olivaceous and clouded with brown, an irregular posthumeral stripe, a broad stripe on upper part of mesepimeron and the greater part of metepimeron.

Legs black, coxæ with a spot, and femora, in subadult specimens, with a proximal inner stripe of yellow. Armature as for subfamily.

Wings evenly enfumed with pale greenish brown or darker brown, this varying widely according to age of specimen, whilst in some, the tint is a rich golden brown throughout whole breadth and length of wings ; pterostigma very long, over 7 to 8 cells, black.

Abdomen black marked with greenish-yellow as follows,—segment 1 with a narrow apical annule and its ventral border ; 2 with a broad lateral stripe constricted at its middle and then dilated at apical border, and the ventral border narrowly ; segments 3 to 6 with baso-lateral half-rings confluent with a lateral stripe, which on 3 and 4 runs the whole length of segment, on 5 for the basal half and on 6 for the basal third only. On segments 7 and 8 only the basal ring, and a ventral stripe on apical two-thirds of latter.

These markings may be largely obscured in fully adult specimens, especially towards the hinder segments.

Anal appendages black ; superiors sub cylindrical, flattened and partially dilated towards the apical end of middle third, widely separated at base, apices curling gently in and meeting or overlapping one another, and hollowed out on their outer side. Inferiors very short, thick, closely apposed, aborted and not visible in profile.

Female. Abdomen 32 mm. Hindwing 33 mm.

Head : eyes dark olivaceous brown, bluish grey beneath ; rest of head black with a vertical stripe on the cheeks bordering the eyes, a transverse stripe on lower part of frons, slightly interrupted by a triangular wedge of black below, the bases of mandibles and two long oblong spots on labrum creamy to citron-yellow.

Prothorax black with a large oval spot on each side of middle lobe and a small spot on outer side of posterior lobe citron-yellow.

Thorax black marked with bright citron-yellow as follows,—antehumeral and humeral narrow stripes squarely confluent above and meeting at a point below, the humeral often interrupted at its middle. Laterally three stripes, the hinder very broad and covering the whole of metepimeron except for a small elongate black area anteriorly and below ; the two anterior stripes separated from each other and from the hinder yellow by narrow black stripes which map out the lateral sutures. A small spot of yellow beneath partially obscured by pruinescence. Legs as for male but more yellow within.

Wings hyaline more or less enfumed according to age ; pterostigma 4·5 mm in length, black, over 7 to 8 cells ; venational details as for male ; 30 to 36 antenodal nervures in forewings, 19 to 20 postnodals ; 25 to 26 antenodals in hindwing, 19 to 21 postnodals ; discoidal cell traversed once or twice, usually twice in the female, once in the male ; 3 cubital nervures in all wings in both sexes ; *1A* not usually forked.

Abdomen black with markings similar to the male but very vividly defined and the ventral stripes continued to the 7th segment. Segment 9 with a very large triangular spot on each side covering its apical half. Anal appendages slightly longer than segment 10, acutely pointed, black.

Distribution. Coorg, S. Kanara, Agency tracts, Jeypore. The exact distribution of this insect has yet to be worked out. Its occurrence in the Eastern Ghats came as a surprise and when coupled up with the occurrence of such western species as *Rhinocypha bisignata*, *Zygnoyx isis*, *Gynacantha millardi*, *Burmagomphus pyramidalis*, *Anax immaculifrons*, etc., throws a vivid light on the path along which distribution and spread of species has taken in the past. The Gangetic plain lies however like an impassable sea between these montane areas and the Himalayas to the north, and we have yet

to learn how the southern fauna originated. From its high specialization, we can only judge that aeons of time have separated and isolated the southern fauna from the northern.

This species was the first of its genus to be taken within Indian limits, and from its appearance, would appear to be the most primitive.

In Coorg it is taken all along the course of the Cauvery and many of its tributaries, being less common in the Hatti and Harrangay rivers. The type female was taken a quarter of a mile from the river.

Mr. C. A. Souter has since discovered the species in the Agency tracts on the eastern side of India but it is not known to occur in any other part of the intervening area. Type in B. M.

Dysphaea walli Fras. Rec. Ind. Mus. vol. xxix, pp. 82–83 (1927).

Male. Abdomen 35 mm. Hindwing 31 mm.

Head glossy black with a small yellow spot on the upper part of each cheek and the bases of mandibles obscurely ochreous; rest of head unmarked; eyes black above, dove grey beneath.

Prothorax black with a large oval citron-yellow spot on each side of middle lobe.

Thorax black marked with citron-yellow as follows,—narrow ante-humeral and humeral stripes confluent above by a connecting bar which runs parallel with the alar sinus, converging and confluent below; four stripes on the sides and an upper vestige of a posthumeral. Of the four stripes, the most anterior lies on the first lateral suture, the second covers the posterior half of the mesepimeron, the third borders the metepimeron anteriorly and above, whilst the fourth covers the posterior half of that structure. Beneath black.

Legs black, the hinder pair of femora broadly yellow or obscurely so on the outer side.

Wings very palely and evenly enfumed, the bases of all four dark blackish brown for nearly two-thirds the distance from base to node in forewings, and fully three-fourths of that distance in the hind, the outer margin of the fascia being slightly convex; 27 to 28 ante-nodal nervures in forewings, about 20 postnodals; 19 to 23 antenodals in hindwings, 18 to 21 postnodals; discoidal cell traversed once or twice in all wings, more usually twice; 3 cubital nervures in all wings; pterostigma black long narrow, over 6 to 8 cells.

Abdomen black marked with blue or citron-yellow as follows,—segment 1 with a large triangular yellow spot on each side; segments 2 to 5 with a lateral stripe azure blue, broad at base where it ascends somewhat on the basal margin of dorsum, tapering to a fine point at the end of each segment. Remaining segments unmarked.

Anal appendages black, the inferiors closely apposed, vestigial and not visible in profile; superiors nearly twice the length of segment 10, seen laterally, broad at base, tapering to a subacute apex which is bevelled downwards. Seen from above, narrow at base, broadening apicad and then slightly narrowed again, compressed markedly in their apical halves. Apices curling strongly in to meet or actually overlap.

Female. (Unknown.)

Distribution.—Maymyo, N. Shan States, Upper Burma. Four males collected by Col. F. Wall, I.M.S., May 30, 1924. Type in B. M.

(*To be continued.*)

A SHIELD-MAKING BEETLE
(*SINDIA CLATHRATA*, F.)

BY

MAJOR R. W. G. HINGSTON, I.M.S.

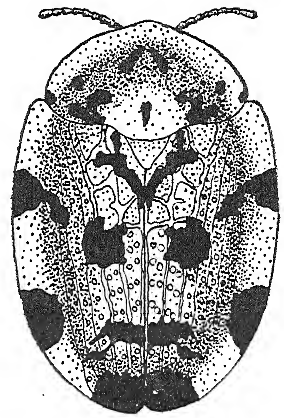
(*With a plate*)

Here is a strange device. There seems to be no end to Nature's ingenuity when it comes to sheltering her creatures from attack. This is a shield manufactured of excreta, a kind of plate under which the insect hides. We find it on the larvæ of the tortoise beetles. They are odd-shaped insects. As their name implies, they look like miniature tortoises. Some of them are brilliant beyond description, shining in a varied glow of colour that reminds us of precious stones.

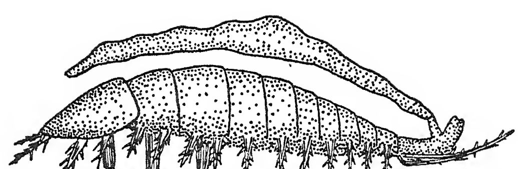
The one in question is *Sindia clathrata*. The rains is the time to look for its larvæ. I found them at Jhansi towards the end of July. The central plain of India was then green and fresh; the dense thorny jungles dripped with moisture; all vegetation was rich and copious from the refreshing influence of the monsoon. What the larva liked was *Rivea hypocrateriformis*, a wild creeper with heart-shaped leaves that roped itself around other trees. One morning I found this creeper covered with black blotches. At the first glance it looked like some fungus growth. On closer inspection I saw the fungus move. Then it was apparent that these were larvæ concealed in some extraordinary way.

The problem was clearly worth investigation. Each larva was all but invisible; what one saw was a flat triangular plate, black and roughened, obviously composed of a multitude of particles moulded into a kind of dorsal shield. With the tip of a straw I tilt up the shield. It is freely moveable. Behind only is there a point of attachment. The shield lifts up and turns backward like a lid fixed on a posterior hinge. Underneath is the owner, the manufacturer of the shelter, a delicate tortoise-beetle grub.

We first look to the larva. It is oval, distinctly flattened, the head somewhat more rounded than the tail. When fully grown, its length is about half an inch. Its colour is dark brown, almost to black; three pairs of legs support it underneath: its back is raised into a longitudinal ridge suitable for bearing the saddle-like shield. Particularly conspicuous is its sharp margin. This bristles all round with spines, not just simple processes, but complicated daggers, each consisting of a central spike ringed about with shorter points. They jut out in a line along either flank, thus forming an armamentarium all round the body that projects from beneath the edge of the shield. The two at the head end are strongly bifurcated. All are acutely sharp. Each spine looks as if fitted with a special poisonous tip. Obviously they are of defensive value. The shield protects the larva's back: the spines guard its flanks.



ADULT × 4.



A SHIELD-MAKING BEETLE (*Sindia clathrata*, F.) LARVA × 8.

Now turn to the shield. It is a kind of adjustable backplate, a hard flat lamina of fragmentary debris, slightly concave underneath so as to fit over the body and almost flat above. Roughly triangular, with the base behind, on either side it is prolonged a little outward something like a pair of wings. Black in colour like its owner, it is of a toughish consistency, but somewhat friable as one might expect from its source. As a shield it fulfils the function excellently. The larva's back is completely covered. Scarcely a chink is open to invasion. Just the head peeps from under the front of the investment and some spines project from either side. As we have seen, the shield possesses mobility, being attached to the larva at one point only, the extreme tip of the tail. It can be raised and lowered at will. Ordinarily the tail is bent over the back, and then the shield is in its natural position. A straightening of the tail means an elevation of the shield; a bending forward of the organ brings it back into place again. What an excellent device, an adjustable armour under voluntary control.

The purpose of this shield is scarcely open to question. It must be a protective device. What are the enemies? No doubt parasitic diptera and hymenoptera, minute foes but none the less dangerous, capable of perforating a delicate skin but unable to get through the shield. Also the backplate must be a disguise, so altering the shape and appearance of the insect that no one would imagine that the roughened flakes concealed a living creature underneath. Numbers of black ants haunt the creeper. I never see them molest these larvæ. They run about in the vicinity but make no attempt to capture them; these dried up flakes with their hidden owners show so little indication of being alive.

But the wonderful thing is the manufacture of the shield. It consists of a mixture of skins and excrement, the outside and inside refuse of the larva refuse cemented into a solid mass. Under the microscope we see its constituents, pieces of dried skin, old coverings of spines, fragmentary material which the larva has cast off. All are cemented together with excrement ejected from the larva's gut. What an excellent use to make of exuviæ! Economy is a rigid principle in Nature. Certain spiders eat their disintegrated webs: some newly-born caterpillars devour their egg-shells; grasshoppers gobble up their moults. This is another good example. Rejected skins and undigested food are welded into a protective plate.

The shield is sometimes a kind of garden. Springing from it is a growth of fungus. There are delicate stems and leaf-like processes which often give it a woolly appearance making it still more like a patch of mould. Of course it is minute, a microscopic vegetation. It grows thick when the larva is imprisoned. A heap of white wool springs up luxuriantly, favoured by the damp air and fertilized by rich manure. What an odd protective combination, a garden on a plate of excrement and skins!

A pair of spines holds the shield in position. They project from the tail, are stiff and pointed, equal in length to the larva's body, and firmly embedded in the plate. The skins, on being shed, are passed back to the tail, then out along these caudal spines. There they accumulate, become spread out into the groundwork of the

shield. The sheddings fit the shape of the backplate. The earliest, being small, make an apex to the structure; the others, being successively larger, give it the triangular shape. Thus it grows by repeated addition of exuviæ, keeping pace with its owner's development and protecting it from the very start.

The spines of course move with the tail. Hence the mobile plate. I touch the larva beneath the edge of its shelter. Down comes the shield tighter on its back. I find one with the shield raised. A gentle stroke on its exposed area brings the structure back into place.

Now a word as to manufacture. How is the excrement applied to the skins? This is best observed when the larva is quite young. I collect a batch of eggs. They have been layed upon the food-plant, minute ovals, somewhat flattened, one-sixteenth of an inch long and one-thirtieth in width. The shell is smooth, pale yellow in colour; its margin is fringed all round with spicules that probably help to hold the egg in place. Over it lies a translucent covering, a waterproof film like dried-up varnish, that protects it from wet and binds it to the leaf.

The surface of the egg darkens with age. On the sixth day hatching occurs. A larva slips out from the interior leaving the shell to all appearances intact. I happen to catch it in the act of emergence. The aperture of exit is at the pole of the egg. Head first it pushes out of the prison. Ventral surface upward, back against the leaf, it clutches the outside of the eggshell and pulls itself into the world. It is minute, exquisitely delicate, almost transparent, faintly tinged with green, broad at the head, tapering to the tail which ends in a pair of spines. Around it is a fringe of spicules. The tail is erect, bent over the back as when employed in carrying the shield. Of course there is no trace of the backplate; the larva is quite naked on its entrance to the world. Its length is scarcely one-sixteenth of an inch exclusive of the caudal spines.

From the moment of birth it displays activity. What protection does it need? Scarcely any at this stage. It is so minute that no enemy would notice it. Moreover, being faintly tinged with green, it does not make even a spot upon the leaf. Life becomes now a chewing at the foliage, for the first few days just a nibble at the epidermis, later on borings through and through the leaf. Growth is slow. By ten days its length is one-fifth of an inch: after eighteen days it is the size of a pea.

Our best time to observe it is when quite young. We can then discover its shield-making machinery, how the excreta is applied to the plate. I place a young larva beneath the microscope. It is feeding on a leaf, just moving quietly from side to side. Its hind extremity is the point of interest. There the termination of the gut is visible, not an orifice flush with the surface, but a cylindrical projection looking like a tail, a tube with an upwardly directed mouth. This protuberance sticks outward and upward. It is mobile, under the control of the larva, can be held erect or bent downward until its tip touches the leaf. I focus the tip of this protuberance. Nothing happens for a time. Then I see a strange

thing, an apparition, which immediately discloses how the backplate is made. The rectal protuberance begins to lengthen. A finger-like dilatation comes out from its interior. Slowly but quite perceptibly, the elongation develops, the protuberance unrolling itself something like a telescope until it is almost the larva's length. This is really a wonderful transformation, a huge voluntary prolapse of the rectum; the gut is being turned inside out. The prolapsed part is pale, almost transparent, just a little tinged with green owing to excrement showing through the wall.

Now observe the purpose of this extraordinary telescope. I see it carried forward over the larva's back. Its tip is then applied to the triangular shield and a drop of excrement squeezed out. What a purpose! It is the organ for manufacturing the backplate. The shield is made with a telescopic gut. I continue to watch. At intervals of a few minutes, as fresh supplies of fæcal matter accumulate, this remarkable rectal protrusion takes place. Drop after drop is added to the shield. The additions are fluid, soon they harden, in fact the excrement is a mortar which binds the skins into a solid plate. A few hours after birth the larva attaches its first drop. The excrement is then a thin liquid: later it exudes in small lumps which materially thicken and strengthen the shield. At all times it is dense black. Can this colour be a special modification? Insects and larvæ that eat green food as a rule excrete green waste. Here is an unexpected change in pigment. What goes in bright green comes out dense black. The machinery for protection is not merely superficial. Changes take place in the larva's interior; pigments are elaborated and mixed with the excreta in order that the backplate may resemble mould.

Nature, indeed, produces wonderful contrivances. This is one of the oddest and most elaborate: a framework of spines, a plate of excrement and skins, a protrusive telescopic rectum to serve as a manipulating hand. And all this for one purpose, to supply a protective device.

Just a few words to complete the larva's development. When full grown it becomes a pupa, an odd-looking spiculated lump. Flattened, raised dorsally into a hump, scales and thorns enclose it, the larva's shield is still fixed to its back. The pupa too has protective armour. In front is a barricade of spines, along the sides is a line of scale-like protuberances, the hind extremity ends in a telson something like a lobster's tail. There is one weak point in the middle of the back. There the integument is thin and vulnerable. But over it is the old shield that protected the larva, now a saddle across the pupa, hard and black and rigid as ever, still serving as a plate of armour even in this quiescent stage.

From the pupa comes the beetle, the miniature tortoise. Weak and soft on first emergence, it takes a day or two to stiffen its integument, also to develop that pattern of spots which adds such adornment to its glistening dress. Oval, half an inch in length, bright yellow with a metallic sheen, its back is carved into pits and ridges and decorated with an elegant pattern of spots. Its reptilian-like investment covers it completely. Only the antennæ and the tips of the legs appear beneath the edge of the carapace. All in all

it is a curious insect, in itself almost as strangely fashioned as is the larva in its mode of defence.

Conspicuous, undesirous of concealment, it keeps to the exposed leaves. Patches of excrement tell us of its whereabouts. No longer required for defensive architecture, the ejections now stain the green vegetation with blotches of black tar. Very sensitive to intrusion, the slightest touch disturbs it. Down it tumbles from its seat on the creeper and is lost in the undergrowth beneath.

So much for *Sindia*. Like a snail it carries a roof on its back. The construction of tenements is common amongst larvæ. We meet with some remarkable instances. Psychid caterpillars cut stems, bind them with silk, and shape the edifice into a cone. Chrysopa larvæ collect empty skins, usually aphids sucked dry of juice, and pile this refuse on their backs. Caddis larvæ make cylindrical cases from leaves or stones woven with silk. The tortoise beetles equal any of these. They have not even to collect materials; they just accumulate their skins and dung.

THE MAMMALS AND BIRDS OF KASHMIR AND THE ADJACENT HILL PROVINCES

BEING

NATURAL HISTORY NOTES

BY

COL. A. E. WARD

PART VIII

(*With a plate*)

(*Continued from page 716 of Vol. XXXII.*)

ARCTOIDEA

Family—*Mustelidæ*. Martens, Weasels etc.
Genus—CHARRONIA

The Pine Marten—*Charronia flavigula*

A special genus was recently established for the Indian Martens for which Gray's name of *Charronia* was available. The genus *Charronia* is represented in Kashmir and the adjacent provinces by the typical race *Charronia flavigula* (*Mustela flavigula* of Blanford).

Charronia flavigula has various vernacular names e.g. *Tuturala*, *Chitrâla*, but the commonest name is *Gran*.

Colour—Head, nape, hind neck and rump, tail and legs brown or black; chin and upper throat are yellowish-white, stomach yellowish; black specimens are rarely found.

Head and body of a very large specimen 24″.

Weight of a specimen shot in the Liddar in Kashmir 9 lbs. This specimen I sent to the British Museum.

Distribution.—Throughout the Himalayan region from east to west, also in the Burmese hill ranges.

Habits—Hill forests are the chief abodes. They live in families which hunt together; whilst hunting, among brushwood if these martens come on some object that disturbs them they will jump on to a rock and peer around and then scuttle up into the trees.

The Pine Marten kills birds and any mammals it can overcome, often catching musk deer. Monsieur Henri Dauvergne saw a family of these martens kill a young markhor in the Kajnag Hills. In Jousar I saw a family catch a musk deer. Very often cicadas are eaten and so are berries. I once saw three or four Indian Martens go for a young wild pig, but this was too much for mother pig to put up with.

Genus—Martes

The Beech Marten.—*Martes foina*

Vernacular name.—*Misr*, etc.

The '*Misr*' or '*Misser*' is sold in Srinagar under the name of Stone Marten, the pelt of which is valuable.

Colour—The colouring of *Martes foina* after it has become adult does not vary much except according to season. Generally it is reddish-grey with a brown hue, or whitish-brown to almost greyish-white in winter at high altitudes; throat and breast pure white. The under parts are nearly always white, thus the variations in colour are seasonal. The Turkestan skins are very light in colouring and for this variety Blanford suggests the name of *M. leucolachnæa*. I do not suppose this name will ever be used; a few of the pelts from Baltistan are exactly like those from Afghanistan and Turkestan.

Dimensions.—Head and body 17″ to about 19″. Tail with hair about 12″; the whole tail is covered with hairs.

Distribution.—Europe and Western Asia. In the Himalayan ranges, from Kumaon to Afghanistan, it is found from about 6,000′ to about 13,000′. The Beech Marten is fond of living in stacks of fuel wood, and frequents the vicinity of small villages. The young are born in the early spring. Like all martens it is very blood-thirsty; it kills poultry in large quantities and is also almost omnivorous. In the Society's Journal (vol. xxi, p. 1320) Lt.-Col. Magrath records seeing a marten at 11,000′ while toiling up a moraine at Sonemurg which was evidently prospecting the mouse-hare burrows under the rocks from which he saw it emerge.

Genus—Putorius

The Tibetan Pole-Cat.—*Putorius larvatus*

This Pole-cat apparently is not found on the south of the main passes leading from Kashmir, but has been obtained in Ladak where it is rare.

Colour.—I have seen European Pole-cats almost exactly like *larvatus*, except that the latter pelts are lighter in colour as a rule. The general colouring is a yellowish-white, the tips of the hairs are deep brown. The face is deep brown; chin whitish; legs and tail deep brown.

Dimensions.—Head and body about 14″; tail 6″.

Distribution.—Ladak and plains of Central Tibet.

As Blanford remarks, it has the habits of the European Pole-cat, but *P. larvatus* lives amongst rocks and loose stones; it seems to be confined to the northern parts of Ladak.

Hodgson was probably the first to obtain specimens of this Pole-cat, but as far as I know he got them from Tibet.

Genus—Mustela

The Himalayan Weasel—*Mustela subhemachalanus*

It has been definitely agreed to restrict the generic name *Putorius* to the Polecats, using *Mustela* for the Weasels.

Colour.—Chestnut red, the shade of red does not vary much. In summer it is plain red, the end of the tail is dark rufous and so is

the nose. The chin is white and there are a few isolated white patches on the upper part of the breast.

Dimensions.—H. & B. 10·80″; Tail 7·00″; H.F. 1·90″; Ear 0·90″; Male, Liddar Valley, Kashmir.

Distribution.—Blanford limits the range of the weasel to the Eastern Himalayas (Nepal and Sikkim) from which it appears to extend to the hill ranges of U. Burma. There is a skin in the British Museum from Mogok (4, 400 ft). I have however seen scores of this weasel in various parts of the province with which I am now dealing. In fact a pair breed under the hut in which I pass weeks every summer.

The White-nosed Weasel—*Mustela canigula*

Colour.—This weasel is said to differ from the preceding species in having its tail uniformly coloured. Further, the white colouring, which in the Himalayan Weasel is limited to the chin and to a few patches on the breast, in the present species extends well round the nose, legs, chin, throat and upper breast.

Dimensions.—The average of 4 specimens measured by me is as follows:—H. & B. 10·4″; Tail 6·3″; H.F. 1·8″ Ear ·9″.

Distribution.—Blanford believes that the White-nosed Weasel is the Western Himalayan species while *subhemachalanus* is the eastern form. 'The former extending its range eastwards from Kashmir into Tibet.' I find it very difficult to separate the two species as the extent of white colouration which is given as a distinctive feature is variable.

The Pale Weasel—*Mustela temon*

Blanford in his Mammalia adopted the name *alpinus* for the pale form of weasel which occurs in Nepal, Sikkim and adjoining Tibet, to which Hodgson's name of *temon* has now been ascribed. *Mustela alpinus* was originally described from the Altais and specimens from that locality show that it is a distinctly larger and stouter animal than *temon.*

Colour.—Above light brown with a tinge of reddish on back and tail. Lower parts yellow or white.

Distribution.—The distribution is given as Nepal, Kumaon and Sikkim. An example of this weasel was obtained by Mr. H. Wells in the Mammal Survey in the Pattan Valley 10,000 feet and at Kyelang (10,380) in Lahul, a subdivision of Kulu.

Habits.—Commenting on the weasels obtained by him, Mr. Wells writes, 'The pale weasel is by no means common, but when the snow is deep in winter a few are generally killed, mostly near villages. It lives amongst rocks and feeds on small animals and birds.'

The Kashmir Weasel—*Mustela longstaffi*

Mustela longstaffi is the trans-Himalayan Weasel, a species intermediate between the Mongol-Siberian form *alpinus* and the cis-Himalayan *temon.* The type described by Mr. Wroughton in the Society's Journal (vol. xx, p. 931) is from Teza in the upper Sutlej Valley (14,000 feet.). In *longstaffi*, the pale yellowish-white of the

belly is quite sharply demarcated from the back and flanks. In *temon* the line of demarcation is less well defined.

Colour.—The general colour above is described as a pale shade of 'clay' colour; below pale yellowish-white. Head slightly darker than the tail, and same colour as the back; hands and toes white.

Distribution.—In the Society's collection there are specimens from Gilgit, from Ladak and Tibet—all obtained at altitudes varying from 13–15,000 feet.

The Indian Ermine or Stoat.—*Mustela whiteheadi*

Examples of Stoat taken in Kashmir and the adjacent provinces are presumably referable to the species which was described by Mr. Wroughton under the above name from a specimen obtained in the Kaghan Valley, Hazara District. The Indian Stoat is distinguished from the European by its much smaller size.

Colour.—The colouration of the Himalayan Stoat differs in no way from the typical European species. The summer coat is brownish with a red tinge, yellowish-white below. Tail tipped with black—a specimen taken by Mr. C. H. Donald is described as 'dull sepia brown on the body very slightly darker on the head which also had the faintest tinge of reddish.

Distribution.—This Stoat is fairly common in Kashmir and Baltistan at high altitudes. The type specimen is from the Kaghan Valley, Hazara District 14,000 feet. A specimen was obtained by Mr. B. B. Osmaston in the Pir Pinjal Range (11,500); while another was obtained at Gondla, Lahoul, 10,000 feet by Mr. H. G. Wells (Mammal Survey Report, *Journal B.N.H.S.* vol. xxxi, p. 602). There are specimens in the Society's collection from Chitral, the Kurran Valley and from Kashmir in addition to those from the Kaghan Valley presented by Major Hannington.

In Volume XXI of the Society's Journal Major H. A. Magrath records having seen a Stoat near Palghar, Kashmir, when crossing a snow patch at about 14,000 feet in surroundings which were nothing but bare rocks and snow. A Stoat was captured by Mr. C. H. Donald at an elevation of 13,000 feet on the Larka pass N. E. of Dharmsala. (*Jour. B.N.H.S.*, vol. xxvii, p. 624) which he took to be a European Ermine, both these specimens are undoubtedly referable to the present species.

Sub-Family—*Lutrinae*

Genus—LUTRA

The Common Otter—*Lutra lutra nair*, F. Cuv.

This is the Indian representative of the common otter of Europe to which Blanford refers under the name *vulgaris*; but as Wroughton has pointed out, the specific name *lutra*, L. is older than *vulgaris*, Erxl. and must be used for it.

Vernacular names—Ud-Udmilau (The Water Cat) *Pani Kutta* (The Water Dog), *Wadar*.

Colour.—The colouring varies from brown to a reddish-brown, some skins have long hairs with light brown tips, these are pulled out by the furriers, until the remaining hairs are of a uniform length, the better skins have close darkish brown covering, which is smooth

Otter, approaching cautiously.

Suddenly disturbed.

Eating fish head foremost.

and sometimes deep brown. The lower parts, breast, throat and sides of the head are whitish—now and again a fine pelt can be got. Lately otters have been a good deal killed off, but in some rivers they are still to be found. It is sometime since I have seen a really good skin fit for making up.

Dimensions.—Head and body from about 24 to 30″; tail 15 inches.

A male otter from the Arrah river, Dachgam Game Reserve weighed 16lbs., a second 17 lbs.

Distribution.—The Indian Otter is generally admitted to be indistinguishable from the European Otter. It is common in the North-West of India and ascends high up into the hills. I have seen them in summer time playing in the snow by the Mar-sar at the head of Dachgam at about 12,000 feet elevation. Wherever trout have been put into the upland tarns the otters find them out. High up amongst the lakes at the head of Wangut ravine, otters are to be found ; apparently they only go high up the streams in midsummer. As a rule the otters in Kashmir can find so much to eat in the well-stocked streams that they become very dainty and fish can be found on stones in the water with only a portion of the shoulder eaten out, whereas in water where fish are scarce, the whole including the head will be eaten. (See Plate, Fig. 1).

They journey a good deal by land, and their wet foot tracks can be found along the edges of small streams, and across belts of sand ; they will trek along the dry land when migrating to the higher waters. Year by year they return to their favourite winter quarters, where the 'Holt' or dwelling place is occupied; this is generally where large numbers of fish congregate in deep pools. Sometimes the approach to the 'Holt' is under water, where it is not easy to find. A family of otters took up their abode under a fallen tree which lay across a small patch of marshy ground; by setting traps in the approaches to this well-concealed dwelling place, three were captured then the others decamped, and took to living under a very large projecting rock which had no approach except under water. One was shot whilst swimming in the river close to the rock, but no place to set a trap could be discovered.

On several occasions in the early spring just before duck shooting ceases, I have seen otters in the deeper and larger jhils and lakes.

The Jumna river in the Dehra Dun and so also the Tons and Ganges contain many otters. I used to stand on a bridge and shoot them as they swam upstream. I have seen as many as 8 or 9 moving about together and far greater numbers have been seen collected on river banks. There is very little difficulty in taming an otter, if caught young; they will get quite tame and follow like a dog, but near a river there is danger of losing a pet otter. Fig. 3 in the plate is that of an otter making a cautious approach when fishing.

In the house they are very troublesome as they upset every water jug, especially in a bath room where they like to dwell when the weather is hot. Tame otters, will eat meat and frogs. They evidently call to one another and the mother calls to the young when she wants to collect and lead them elsewhere.

There is a smaller otter which is more reddish-brown in colouring than *L. vulgaris*, it is perhaps not to be found in the hills in the vicinity of Jumna and Kashmir, etc., but I have seen what I think is this animal on the Ladak river and in Eastern Kumaon. Anyone who sees it will be struck by its small size and if the otter is dry, by the chestnut brown of the head and body. In weight it is said to be 9 to 11 lbs. and I should imagine it is not much more than half the weight of the Common Otter. It is one thing to see otters swimming about in a river and another to secure one when shot, especially in a deep current of water. Moreover when beating in line with elephants, there are often restrictions which prevent general shooting; this was the case when I came on this otter. I failed to find them when I went again to look for them. These otters would not have been without the parent otter if they were *L. vulgaris* for they were too small. It is to be hoped that efforts will be made to get a good series of otters from Kashmir as in the absence of modern material it is impossible to arrive at a sound judgment as to the identity of the smaller species noted by me.

Family *URSIDAE*—Bears

Genus—Ursus

The bears with which we are concerned are the Brown Bear and the Himalayan Black Bear.

The Brown Bear.—*Ursus isabellinus*

The name *arctus* used by Blanford applies to the North European Bear and *isabellinus* is used for its Indian representatives.

Vernacular names.—*Lal Balu*, *Lal Haput*, *Barf-ka-rinch* of Kashmiris. *Drin-mor* in Baltistan and the borders of Ladak.

Colour.—Variable. Some are reddish-brown with the lower parts of the fur yellowish. In the autumn the skins are often very handsome being light in colouring. The handsome skins are those of large bears which can occasionally be shot before they hibernate, the tips of the hairs being yellowish white, but big bears are now very scarce. There seems to be no general rule which governs the colouring, sometime big male bears are very red.

Dimensions.—When writing regarding Big Game shooting I did not dwell much on the size, but I mentioned I had measured one 7′ between pegs, that means from the nose to the root of the tail. It was shot in the 'Gurgai' and gave a huge pelt. I have heard of larger Brown bears, but I think 7′ 6″ which is about the limit given by Adams has probably not been exceeded if the straight measurement between pegs has been adopted.

Distribution. There are a few brown bears in the Hirki Dun above Kumaon, Kashmir, Chamba, Baltistan, the borders of Ladak-Suru and rarely in Zanskar and Gilgit.

The Tibetan Brown Bear is *U. pruinosus* (Blyth).

Habits.—All brown bears hibernate either in caves or under a mass of fallen trees provided this makes a complete covering. They come down from their haunts in the high ground about October visiting the spots where sheep have been folded during the early autumn, and where the grass, wild parsnips and other vegetation

grows. They dig up the ground and visit the same place late in the autumn evenings. Then they go still lower down and get to their winter quarters. When spring approaches they emerge and for a few days loiter about in the vicinity of their cold weather quarters. If snow falls they temporarily go back under cover. After they have fed on any herbage they gradually ascend, keeping below the level of the heavy snow, but if disturbed they will trek for miles across the hard snow.

Ursus isabellinus is generally a vegetarian, but will kill sheep and ponies. That it does this frequently and eats them there is no doubt. Once it has taken to this habit it becomes a pest. In Mir-mullik and in the vicinity of Nanga Parbat I spent many days after a couple of brown bears before I could get one of them. A Brown Bear killed and devoured a large buffalo calf in the Liddar where there was plenty of vegetation and insect life under the stones. It is on the whole a fairly harmless animal but will fight when wounded, sportsmen have been killed when following a wounded Brown Bear, but I have not heard of one ever becoming a man-killer. The sense of smell is keen, sight is poor, and hearing not at all acute.

The pairing season is in the autumn. The young are born in the spring and follow the mother into the snow clad country as soon as they can travel, which is not until several weeks after they are born, for they are very helpless little creatures for some time.

There are a very few Brown Bears left, and it is a pity to shoot them. Luckily they have long lives and if the shooting is still more restricted, there may be hopes for the future.

Genus—Selenarctos

The Himalayan Black Bear—*Selenarctos tibetanus*

Recent studies of the external characters of bears have necessitated the separating of the Himalayan Black Bear (*Ursus torquatus* of Blanford) as a distinct genus under the name *Selenarctos*. Blanford rejected Cuvier's name *tibetanus* as this animal occurs on the southern slopes of the Himalayas and not in Tibet but that, as has been pointed out, is technically an inadmissible objection to the use of the latter name.

Colour.—Black except for the white horse-shoe mark on the chest.

Dimensions.—In my former writings I dwelt at considerable length on the size of the black bear and need not enter this subject again.

Distribution.—Generally in nearly all the forests of the Himalayas.

I have shot them in the Terai in the cold weather and at the foot of the Himalayas, in various places, for this bear does not willingly hibernate, the tendency except for very old animals especially big males is to journey down from the higher altitudes feeding and taking a long time on the way. They visit the oak forests where they greedily devour the acorns and where, as I have before written, they are shot in considerable numbers. Close to oak forests they

will assemble and may be seen after the sun shows on an open hill-side, but directly the heat of the day comes on they go back to the forest.

And then comes the chance of destroying some of these pests.

When the black bear does hibernate, it takes to a cave or a hollow tree and can be dislodged. On frozen snow it will not travel far. It is hard work to plod through the bushes which are covered with snow and it is not worth the trouble to follow them unless the object is to destroy a bear which is known to be harmful. When dealing with a bear which has been much bullied or previously wounded it is necessary to be very careful.

Bears are still plentiful but are very wary. In some parts of the Himalayas especially where they are preserved they do infinite damage. They are very destructive to the young of deer; I have shot several by watching an uneasy hind which has just given birth to a fawn.

Black Bears peel the bark off young pine trees to get at the resin; they also break the boughs of young walnut trees and utterly destroy them, and the damage done to the ripening maize is very trying to the villagers.

(*To be continued.*)

NEW COMMELINACEÆ FROM THE WESTERN GHATS

BY

E. BLATTER, S.J., PH.D., F.L.S.

(*With two text figures*)

Aneilema rigidum, Blatter, *sp. nov*. [Commelinacea sectionis Euaneilematis. Accedit ad Aneilema nudiflorum, Br., sed differt foliis plicatis, vagina foliorum gabra excepto ore ciliato, pedicellis et bracteolis duplo longioribus, petalis magnis.]

Root of stout fleshy fibres. Stem branched from the base; branches straight, rigid, thin, ascending at an angle of about 40° or procumbent, leafy half-way up, striate and with one deep groove, the ridges with a row of very minute hairs and a few long hairs in the groove. Leaves 3-7 cm. by 7-20 mm., lanceolate or linear-lanceolate, acute or acuminate, base narrowed into the sheath, coriaceous, hairy or glabrous on the upper side, glabrous below, sheath glabrous except for the mouth which is strongly ciliate. Flowers in terminal panicles, branches of panicle up to 3 cm. long, scarred where they branch, bract at base of panicle broadly ovate-lanceolate, acuminate or broadly ovate, acute, sheathing, sheath ciliate. Cymes subcorymbose at the ends of the branches; pedicels up to 9 mm. long, rigid; bracteoles broadly ovate, 8 mm. long and almost as broad, cymbiform, scarious, greenish yellow, entire or bifid at apex, caducous. Sepals three, two are ovate-oblong, obtuse, one oblong, obtuse, all scarious, light green, many-nerved. Petals pale purple, broadly ovate or suborbicular or obovate, with a very small claw, obtuse or subacute, 10 mm. long and broad. Perfect stamens two; filament pale purple, up to 8 mm. long, bearded in central third only, hairs very long, bearded, darker purple than petals; anthers 1½ mm. long, versatile, deep blue-black, pollen white. Staminodes four, yellow, dimorphous: three have the filaments not bearded, the sterile pyriform anther-lobes are borne on spreading stalks over 1 mm. long, connective prolonged, beyond the stalks of the anther-lobes and forming a club-shaped rounded body (Fig. 2); one staminode has always a shorter filament and bearded like the perfect stamens, but immediately above the beard there is either a small yellow knob or two short deflexed arms. Ovary narrowly obovoid, 3-celled, green-purple, cells 2-ovulate, ovules ovoid, irregular. Capsule not seen.

Locality: Tableland of Panchgani in grassland, Bombay Presidency (Blatter, P 75).

Flowered 20th August, 1925.

Note: I have never found the base of the leaves cordate or rounded.

The bracteoles are described above as entire or bifid at the apex. It is not impossible that the two lobes are the result of mechanical rupture.

The flowers open towards 4 p.m.

In the above description we have seen three distinct states in the structure of the stamens: two perfect stamens with ordinary fertile anthers and bearded filaments, one staminode with a bearded filament and a knob or two arms above the beard, and finally three staminodes with stalked barren anther-lobes and a thickened prolongation of the connective, but without a beard. I think we are not quite wrong if we consider these three states as three distinct stages in the devolution of the stamens. It would sound paradoxical to call it evolution of the staminodes, though we cannot deny a certain amount of structural evolution in the production of the three staminodes. I give a diagram of how I understand

the devolution having taken place (Fig. 1). We have first the perfect stamen (*a*), then the stamen minus the anther (*b*), then the stamen minus the prolongation of the filament beyond the beard (*c*), then the formation of a knob above the beard, the initial stage of the barren anther (*d*), then a further development of the barren anther (*e*), and finally the separation of the anther-lobes and disappearance of the beard. This beard has remained constant throughout and has disappeared only in the final stage. As staminodes are a common occurrence in the Commelinaceæ and as this family is well represented in India, anybody who wishes to take up the question of evolution or devolution would find plenty of interesting and puzzling material.

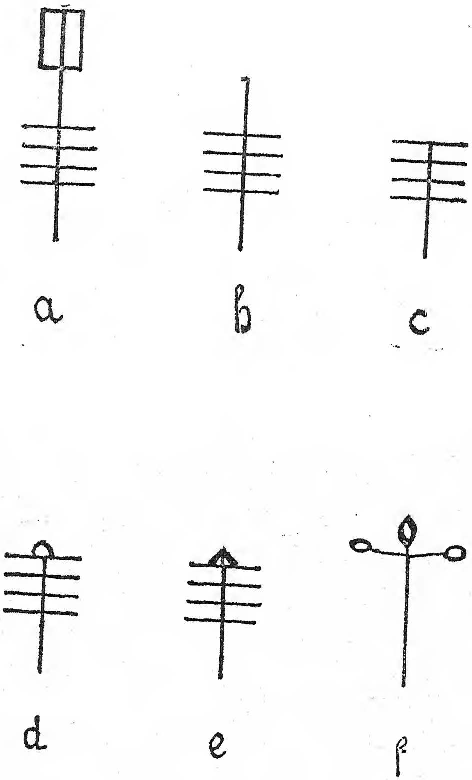


FIG. 1.

Diagram showing possible devolution of perfect stamen in *Aneilema rigidum*, BLATT.

Aneilema Hallbergii, Blatter, *sp. nov.* [Commelinacea sectionis Dictyospermi. Accedit ad Aneilema ovalifolium, Hook. f., sed differt ab eo foliis glabris, panicula non pyramidali, antheris tribus perfectis earumque forma. Similis est quoque aliquomodo Aneilemati conspicuo, Kunth, sed recedit ab eo foliis ovato-lanceolatis, panicula minime pyramidali, paniculae ramis non-horizontalibus.]

Lower part of stem sometimes creeping and rooting at the nodes. Shoots erect, arising from the nodes outside the leaf-sheaths, or terminal, reaching about 50 cm. in height. Lower internodes longer, up to 10 cm. long, upper

shorter, all rather stout, glabrous, deeply furrowed in the dry state. Leaves usually clustered towards the top of the erect shoots; sheaths cylindrical, 2-3 cm. long, oblique at the top, glabrous or nearly so. Blade sometimes absent at the lower nodes, 15 by 4·5 cm., ovate-lanceolate, long-acuminate, narrowed at both ends, glabrous. Panicles terminal among the cluster of leaves, compact, many-flowered, branches angular, puberulous. Pedicels at length reaching 5-6 mm., drooping. Flowers subregular. Corolla pale lilac or whitish. Stamens 3, perfect: one with long stout purple filament and reniform hastate anther, one with shorter purple filament and oblong anther, and the third with still shorter white filament and oblong anther. Staminodes 0, 1, or 2 with white subulate filaments. Pistil white. Capsule subglobose; valves broad, about equal, olive-coloured, glistening when dry. Seeds one in each cell, 4 × 2 mm., slightly curved, obtuse at both ends, greyish white, with a narrow black or brown scar not reaching the ends and a deep circular pit 2 mm. diam. close to the scar, the rest of the surface being ornamented by deep angular pits in four longitudinal rows, the pits being separated by prominent zigzag ridges.

The habit of this species closely resembles that of *Dictyospermum ovalifolium*, Wight, Ic. 2070, which, however, has 'the filament of the petaline stamen longer than the others, at length spirally convolute', and all anthers similar, which is certainly not the case in our species.

Aneilema ovalifolium, Hook. f. in Fl. Brit. India, vi, 382, has only two perfect stamens and thus cannot be Wight's plant.

The new species comes also close to *Aneilema conspicuum*, Kunth, but the panicle is by no means pyramidal, the leaves are ovate-lanceolate, and the seeds can certainly not be adequately described as rugose.

One root was observed reaching nearly 1 m. in length, slender, brown and piercing a leaf-sheath at the base.

Locality: Found by F. Hallberg and C. McCann in the evergreen forests of Northern Kanara, particularly on the Ghats: Devimane Ghat (Herb. St. Xavier's College, Bombay, No. 34571, type); Gersoppa Ghat (Herb. St. Xavier's College, Bombay, No. 34761, co-type); also near Gersoppa Falls on both sides of the river. Not common.

Flowers and *fruits* in October, 1919.

Aneilema siennea, Blatter, *sp. nov.* [Commelinacea sectionis Dichæspermi. Similis Aneilemati lanuginoso, Wall., sed recedit ab eo habitu procumbenti, foliis ovato-lanceolatis basi cordatis, pedicellis bibracteolatis, sepalis viridibus, petalis perfecte orbicularibus.]

A small plant, up to 20 cm. high, much-branched. Roots of many cylindrical tubers up to 2·5 cm. long and many long fibres arising from above the tubers. Stem procumbent in the lower half, often rooting at the nodes, then ascending, leafy, branching, green, glabrous except for a line of bristles running down from the lower end of the mouth of the sheath to the next node. Leaves sessile, alternate, bifarious, flat or subplicate, oblong or ovate-lanceolate, acute or subacuminate, cordate, long-amplexicaul for up to 5 mm., 15-18-nerved, glabrous above and below and puberulous or slightly hairy on the margin, or sometimes hairy above and slightly so beneath and ciliate on the margin (both states being found on the same plant), 5 by 2 cm.; sheath, mouth of sheath and margin of sheathing base stiff-bristly. Flowers usually from the 2 uppermost leaf-sheaths, 1–2 from each sheath, but often from the 4 or 5 topmost leaf-sheaths. Pedicels up to 2 cm. long, very slender, erect, jointed about the middle and there furnished with 2 minute, ovate-triangular, blunt, green bracteoles. Sepals 3, elliptic, boat-shaped, subobtuse, scarious, bright green, 5 by 3 mm., apex turned inwards. Petals 6–7 mm. long and broad, perfectly orbicular, light raw-sienna-coloured, blue when withering, purple in bud. Stamens: 3 perfect and 3 sterile, filaments of perfect stamens twice the length of the others, raw-sienna-coloured, densely bearded with long hairs of the same colour in the lower half, upper half naked; anthers versatile, horizontal, dark violet, opening longitudinally on the lower surface; pollen yellow filaments of staminodes also bearded in lower half; sterile anthers yellow, with a long connective to which two inward-curved anther-lobes are attached (Fig. 2). Style dark purple, narrowly conical, curved, as long as the stamens or slightly longer; stigma white, minute. Ovary cylindrical, sessile, 3-celled, with 3 higher and 3 lower longitudinal ridges, cells usually 5–6-seeded, ovules visible through the walls of the ovary.

Locality : Panchgani, Bombay Presidency, 4,400 ft., on Tableland in low grass in places where there is plenty of water (Blatter, P74, type).
Flowered and *fruited* in Aug. 1925.

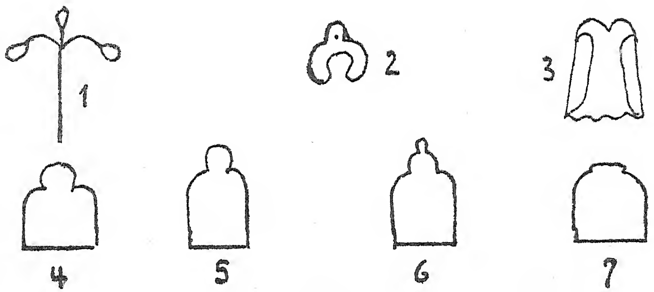


FIG. 2.

1. Staminode of *Aneilema rigidum*.
2. Sterile Anther of *Aneilema siennea*.
3. Ventral Side of Anther of *Cyanotis sahyadrica*.
4, 5, 6. Ovules (Side-view) of *Cyanotis sahyadrica*.
7. Seed of *Cyanotis sahyadrica*.

(All magnified).

Cyanotis epiphytica, Blatter, *sp. nov.* [Commelinacea, sectionis Dalzellias, simillima C. viviparae, Dalz., sed differt petalis fere usque at basim liberie, staminum filamentis barbatis, et pedunculis non axillaribus.]

An epiphytic herb with hardly any stem, consisting of a creping rootstock bearing tufts of leaves which are linear, acute, narrowed at both ends, up to 10 cm. by 8 mm. when mature, the young ones much shorter and rather fleshy, all leaves, particularly the young ones, clothed with rufous hairs appressed above, spreading below. Scapes many from below the tufts of leaves, slender. often more than 10 cm. long, hairy, creeping and rooting at the nodes, viviparous at the apex (from which a new plant develops), having up to 10 internodes and bearing small, elliptic-oblong, acute leaves, one at each node, appressedly hairy above, subglabrous below, with membranous, rufous-hairy sheaths about 2 mm. long. At some of the central nodes of the scape a suberect peduncle arises, sometimes 2 or 3 from the same node, and always below the sheath, not axillary. Peduncles, like the scapes, often with 2 internodes reaching about 1 cm. and bearing much shorter leaves than the scape, the uppermost gathering into a false whorl due to the shortening of the remaining internodes and functioning as bracts for the inflorescence which forms a kind of terminal umbel, generally consisting of one or two flowers. Pedicels about 2 mm. long, clothed by spreading rufous hairs. Sepals three, 3 mm. long, linear-oblong, acute, villous with rufous hairs. Petals three, white, about as long as the sepals, oblong, subacute, free nearly to the base. Stamens 6, 3 longer than the rest, filaments white, densely bearded with white moniliform hairs. Anthers yellow, those of the longer stamens larger. Ovary 1·5 mm. long, ovoid, obtuse, subtrigonous, hispid, especially near the apex. Style several times longer than the ovary, but included and twisted. Stigma small, yellow, capsule 3·5 mm. long, cylindrical, obtusely trigonous with rounded corners, 3-sulcate, slightly broader towards the hispid apex. Seeds 2 in each cell, subcylindrical, slightly compressed, with a translucent greenish outer layer when fresh through which the brown core may be distinguished, pointed at one end, 3–4 times as long as broad.

Locality : N. Kanara, Bombay Presidency. Found covering the lower part of a single large trunk of a tree up to about 10 ft. from the ground in the evergreen forest above Gersoppa Ghat, very rare (Hallberg in Herb. St. Xavier's College, Bombay, Nos. 35002, 35003 type, 35004, 35047 co-types ; No. 7193 in Herb. Sedgwick & Bell).

Cyanotis sahyadrica, Blatter, *sp. nov.* [Commelinacea sectionis Eucyanotidis. Similis Cyanotidi tuberosæ Schult., sed differt ab ea caule nullo modo basi incrassato neque hirsuto, bracteis cymis aequilongis vel eis longioribus, staminum filamentis apice non tumidis, stylo spirali, seminibus apice fere planis minime conicis.]

A stout, coarse, hairy plant, about 30 cm. high. Root of fusiform tubers, producing two aerial structures side by side ; a true stem and a pseudo-stem. True stem solitary, suberect, very thin at base, rooting without radical leaves. cauline leaves few (4 or 5), ensiform, acute, scarcely narrowed below, amplexicaul, 7 cm. by 16 mm., scantily long-hairy on upper side, densely covered with shorter hairs, on margin and lower surface, grass-green above, paler below, sheath 2 cm. long, very tight, densely pilose. Pseudo-stem formed by the sheaths of about 4 radical leaves. Leaves up to 20 by 3 cm., linear or lanceolate or linear-lanceolate, acute at apex, sheathing, leathery, on upper side sparsely long-hairy, margin and lower surface densely clothed with shorter hairs, grass-green above, paler below, sheath half-amplexicaul, long—and dense-hairy. Cymes axillary and terminal, scorpioid, compact, villous, producing about 14 flowers, 17 mm. along the long diam. Peduncles 1–2½ cm. long, grooved, velvety hairy, usually several (up to 4) together from a large, ovate-lanceolate, acute, hairy, falcately deflexed leaf, 2–6 cm. long and 5–17 mm. broad. Bracts ovate-lanceolate or lanceolate, foliaceous, 2 cm. long, 5 mm. broad, as long as the cymes or more often longer, hairiness the same as in cauline leaves Bracteoles falcately ovate or ovate, acute or subacuminate, imbricating in 2 series, ciliate on margin, villous on lower surface, subscarious, brown-purplish in the upper part of convex margin. Sepals 3, united at base, villous outside, lanceolate or oblanceolate or linear-lanceolate in the same flower, very acute, shining smooth on inner surface. Petals 3, united into a tube, 4 mm. long, whitish, passing slowly into a pale blue and dark blue at the apex of the lobes, longest lobe 4 mm. long, just as long as the tube, another ⅓ of the tube, all obovate or suborbicular, apiculate, apex reflexed. Stamens 6, hypogynous. Filaments white, about 1 cm. long, spirally twisted near anther which part is bearded with very long, dark blue bearded hairs, cells of hairs sometimes elongate or rounded. Anthers orange-yellow, 2 mm. long, broader at tip than below, shaped like a closed fan from which the lower half has been cut off (Fig. 2). Pollen golden-yellow, bean-shaped. Ovary ellipsoid with a very thick coat of stiff yellowish brown hairs. Style 2 cm. long, twice as long as the stamens, spirally twisted, filamentous, white, spindle-shaped below stigma, with a tuft of blue hairs below the thickening. Ovules 6, shortly subcylindrical, truncate at base, umbonate at tip, with a constriction between the umbo and the cylindrical part (Fig. 2). Capsule 3–4 by 2–3 mm., ellipsoid-obovoid, upper half hairy, lower glabrous, slightly trigonous. Seeds broadly ovoid, 1–2 mm. long, slightly narrower, somewhat compressed, truncate at base, flattened on one side, rounded at apex, rugose. (Fig. 2).

Only one flower of the cyme opens at a time : the stamens are exserted and the corolla just reaches the level of the bracteoles.—The umbo of the ovule has disappeared in the seed and only a plano-convex disk is left at the tip of the seed. The seed after removal from the capsule is white, but turns brown after a few minutes.

Locality : Panchgani, Bombay Presidency, about 4,000 ft., in grassland, two miles towards Wai (Frenchman P38).

Flowered and *fruited* 19th July 1925.

DONGTSE

OR

Stray Bird Notes from Tibet

BY

F. Ludlow

(With two plates.)

Tibet is a land of lakes. Open any good map of the country and you will find them scattered throughout the length and breadth of the plateau like so many creeping amœbæ—lakes of all shapes and dimensions, big, little; deep, shallow; fresh, salt. On these lakes, amidst the vast solitudes of the great tableland, the Bar-headed Goose breeds in myriads, undisturbed and unmolested, save by its own feathered enemies, and the few Tibetans who take its eggs. Then winter comes. The lakes freeze to a depth of several feet. Food is unobtainable, so the geese must perforce depart. Some turn south and descend to the fertile plains of India, but many remain in the lower valleys drained by the great Tsangpo. Here the rivers still flow albeit choked with ice, and the midday sun has still sufficient power to thaw the frozen ground. It is in these 'rongs' or cultivated valleys of Southern Tibet that the Bar-head will be found in winter, either in fields of barley stubble or sunning themselves on shingly river banks. In similar situations there will also be Brahminy Duck innumerable, and here and there flocks of Black-necked Crane (*Megalornis nigricollis*).

As regards duck, Mallard and Common Teal alone remain throughout the winter in small numbers. Gadwall, Wigeon, Shoveler, Pintail and the various Pochards just pass through hurriedly on migration, to feed themselves fat on Indian jheels.

It was late in December 1924. The old year was almost dead, and save for scraggy Tibetan mutton our larder was empty. Something had to be done and that quickly, otherwise we should fare ill during the New Year. There was no game in the immediate neighbour-hood of Gyantse. 'H' and I had scoured the country for miles around and had hardly seen a feather. So we decided on a trip to Dongtse, a day's march distant. This, of course, meant sleeping in a Tibetan house with a temperature down to zero, and no fire-place to huddle over in the evening.

But this chilly prospect did not deter us and off we started at sunrise on our sturdy Tibetan ponies; our food and bedding and that of our servants on, three mules in the rear. It was piercingly cold, but there was no wind. What a terrible enemy the wind is in Tibet; without it the climate would be perfect, but when it rages as it too often does in winter, the climate is execrable. To be caught in a Tibetan blizzard in mid-winter is an experience no one ever forgets.

You may wear all the woollen clothes in your wardrobe and you will be chilled to the bone. You may swathe your face in a mask or muffler, wear the most wonderful dust-proof glasses ever fashioned, and it will be of no avail. Your eyes, mouth, nostrils will be choked with sand, your breath will freeze, and the icy spicules on your mask or muffler will sear your face like sandpaper. In Tibet, with all due deference to Gilbert, there is no 'beauty in the bellow of the blast', —at any rate, in winter. As we ambled along across the stubbly barley fields to Tsechen we disturbed flocks of Horned Larks (*Otocorys alpestris elwesi*) and Mountain Finches (*Montifringilla nivalis adamsi*) whilst every now and then the Tibetan Sky-Lark (*Alauda arvensis inopinata*) would rise almost beneath our ponies' hoofs.

Of all the songsters in Tibet I think we exiles loved the sky-larks most. As soon as the first green growth showed itself in spring they would burst into praise, and then onwards right through the summer the valleys simply rang with their song. Indeed, so full of joyousness were they, that on clear bright moonlight nights one would sometimes hear them singing two or three hours before dawn. Crossing the Nyang-chu River by a typical Tibetan stone-pier bridge we investigated the swamp at the foot of the village of Tsechen in the hope of finding geese, but were disappointed. A few Brahminy alone greeted us. These we left in peace for we seldom shot Brahminy, partly because they are not very palatable, and partly because they are venerated by Tibetans and are so absurdly tame. I always felt more inclined to feed these birds rather than shoot them, for they would generally allow one to approach within fifteen or twenty yards, and would then show no more fear than the average duck in a London park.

It is no uncommon sight to see these ducks waddling about on the flat roofs of Tibetan houses, and in some places they will even nest inside the houses in old lumber rooms. As everybody knows, the Brahminy in India is one of the wariest of ducks and the fearlessness it displays in Tibet is therefore all the more astonishing.

Leaving Tsechen we soon found ourselves in thick Buckthorn jungle (*Hippophæ rhamnoides*), over which the Tibetan Clematis (*Clematis tangutica*) climbed in dense and tangled masses.

Bird life here was particularly abundant, and none was more conspicuous than Guldenstadt's Afghan Redstart (*Phœnicurus erythrogaster grandis*); the male gorgeously attired in chestnut and black with a snow-white wing-patch and crown, the female more sombre looking like a big edition of the Indian Redstart.

Rose Finches (*Carpodacus rubecilloides lapersonnei*) and (*Carpodacus pulcherrimus davidianus*) also abounded and flocks of Tibetan Twites (*Acanthis flavirostris rufostrigata*), most persistent of chatterers. Here and there the Robin Accentor (*Prunella rubeculoides*) uttered his sharp '*tik-tik*' as he darted from bush to bush, whilst at intervals we saw the Brown Accentor (*Prunella fulvescens fulvescens*), easily identified by reason of his long white supercilium.

Once we caught a glimpse of a pair of little Tibetan Tit Warblers (*Leptopœcile sophiæ obscura*) resplendent in purple and lilac, restlessly searching for food in the thick undergrowth.

Then, crossing a flowing stream fed from warm springs, we put up a pair of Ibis-bills (*Ibidorhynchus struthersi*) which flapped lazily away uttering their characteristic oft-repeated cries. This strange bird has a remarkable altitudinal range in winter and may be seen on the Teesta and its tributaries a few hundred feet above the Indian plains, and at elevations of 13,000 feet and over on the rivers of the plateau. The eggs of the Ibis-bill were unknown for many a long year, and even now are rare in collections. Yet they are not difficult to find once you know *when* and *where* to look for eggs, and *what* sort of eggs to look for. Here is the recipe. Look for eggs the last week in April or first week in May ; search for nests on high ground in stony river beds especially where the river bifurcates to form an island ; and keep your eyes open for four sage-green, brown-spotted eggs in a shallow depression amongst the shingle. If, by great good luck, you should stumble across a month-old chick, send it to South Kensington, and the Museum authorities will offer you their best thanks.

Immediately after putting up the Ibis-bills we saw what appeared to be the father of all snipe strutting about quite complacently on a small bare patch of swampy ground. It was so tame that it allowed us to approach within ten yards before it rose. 'H' then crumpled it up, and it turned out to be the Himalayan Solitary Snipe (*Capella solitaria*).

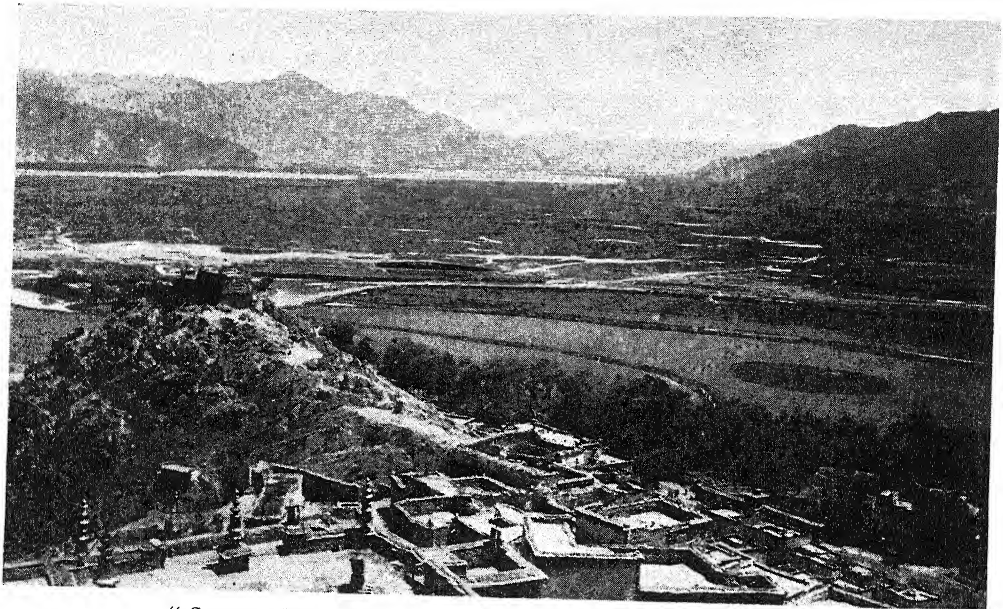
Leaving the scrub jungle behind us we made for the river, and after meandering along for three or four miles, we suddenly came on a flock of a hundred or more geese, basking in the sun on the opposite bank.

They allowed us to approach within range but the river was unfordable and it was useless to shoot. So we threw stones at them instead, and off they went down stream loudly protesting. On and on they went until they had almost disappeared from sight. Then they performed a most perfect 'about wheel' and came back straight towards us. When they passed over us they were so high that I thought them out of range and never even raised my gun. 'H' however, gave them his choke barrel and winged an old gander which come hurtling through the air to fall with a tremendous thud at our very feet. After this we made poste-haste for Dongtse. Before leaving Gyantse we had armed ourselves with a letter of introduction to the head steward of a large house belonging to the Phala family, and this we presented. We were immediately admitted into a huge Tibetan building several storeys high, built in the form of an open square,—the stereotyped design for a Tibetan house. A large open courtyard occupied the centre. The ground floor was devoted to stabling and godowns.

Ascending a series of steep wooden ladders which did duty as stair-cases, and having passed through several perilously low doorways (built purposely to keep out evil spirits), we eventually reached the guest chamber, a big room with a low ceiling supported by wooden pillars, and a latticed paper-paned window overlooking the courtyard. A hundred images peered down upon us from niches in the wall. The customary scarf of greeting having been presented, and a few cups of 'chang' (slightly alcoholic barley water), having

" A most grotesque Lama dance or 'cham.' "

" Four sage-green brown-spotted eggs in a shallow depression amongst the shingle."



" Commands a glorious panorama of the Nyang-Chu Valley."

" The rivers still flow, albeit choked with ice."

been quaffed, we thanked our host for his kind hospitality and scampered off on our ponies to explore as much of the neighbourhood as possible before dusk.

We soon saw several flocks of Black-necked Crane. They are normally very shy birds, and often the only possible way of getting within gun shot is to circle round them on a pony gradually drawing closer and closer, just as a Sindhi shikari stalks ' houbara '.

In this way we got within range of three birds, and then flung ourselves from our ponies and did a little rapid fire. All went off apparently uninjured, but one bird having gone half a mile suddenly collapsed, and we retrieved it with great joy. We then discovered a flock of twenty geese out of which we accounted for three. It was now getting dusk, and a few flakes of snow began to fall, so we mounted our ponies and cantered back to our quarters, where we consumed much tea and toasted ourselves over a brazier fire which our host had most thoughtfully provided.

Dongtse is an interesting place quite apart from its natural history. It possesses a famous monastery, which is built on a rocky mountain spur, and commands a glorious panorama of the Nyang-Chu Valley stretching as far as Gyantse thirteen miles distant. Forty-six years ago an erudite Bengali schoolmaster named Sarat Chandra Das visited this monastery and stayed for some considerable time with Lama Sengchen Dorjichen the abbot, who was a Tibetan scholar of great repute and an incarnate Lama to boot. The Lama helped Sarat Chandra Das to reach Lhasa, which in those days had not previously been visited by any Britisher save by an eccentric English gentleman called Thomas Manning in 1811. In due course the Tibetan Government learnt that Sengchen Dorjichen had assisted Sarat Chandra Das in his enterprise, and became so infuriated that they took the Lama prisoner and threw him into the Tsangpo.

Accounts of the method by which he was drowned differ. One version relates that he was sewn up in a sack and cast into the Kongbu Tsangpo ; another, that a stone was tied round his waist and that he was lowered into his watery grave at the end of a rope.

From Lama Sengchen's private apartments (carefully preserved and treated with the greatest respect to this day), one can see on the opposite side of the Nyang-Chu Valley a few miles distant, the hermitage of Nyang-Tö-Kyipo. Here Tibetans undergo voluntary immurement in dark cells for varying periods, sometimes for life. I once paid a visit to this place, but the story of these hermits, like the cells in which they live, is dark and depressing, so we will pass it by. The curious reader of these notes if he so wishes, will find a vivid description of this hermitage together with further details of Sarat Chandra Das and his visit to Lhasa, in two books dealing with the Tibet Mission of 1903–04, viz., Landon's *Lhasa*, and Waddell's *Lhasa and Its Mysteries*. But what the reader will not find in any book on Tibet that I know of is a reference to the picturesque monastery of Tenchokling situated up a side nallah two miles to the south of Dongtse. I once spent two glorious summer days in this monastery and witnessed a most grotesque lama dance or *Cham*. The numerous actors in this religious performance

wore costumes of priceless old Chinese brocade and the whole drama was wonderfully staged. But what interested me more than the fantastic dance, was the beauty of the surroundings and the fauna and flora of the neighbourhood. The monastery had not been erected on the bare and barren slopes of a mountain as monasteries so often are in Tibet, but right down in the valley bed in the midst of a veritable forest of poplars and willows. Peach trees were everywhere, and wild rose, barberry and buckthorn bushes formed a dense undergrowth, the whole of which was irrigated by the waters of a rushing mountain stream. Buttercups, primulas, delphiniums and a host of other familiar temperate flowers starred the open glades. Burhel and gazelle betrayed no fear, and fed unconcernedly in the adjoining barley fields. Black-rumped Magpies and Black-eared Kites nested in the poplars and willows, and Rufous Turtle Doves, Grey-backed Shrikes and crowds of smaller birds in the thick bushy undergrowth.

Even the Giant Babax (*Babax waddelli*), generally the most confirmed of skulkers, seemed to have shaken off his shyness in this peaceful sanctuary, and hopped about fearlessly in the open at a considerable distance from his beloved buckthorn thickets.

But it is time we returned to Dongtse, for hermitages, monasteries, Bengali schoolmasters and incarnate lamas are subjects which are not usually discussed in the pages of a natural history journal.

It was bitterly cold that night and though 'H' and I sleep in all our clothes and pulled blankets and rugs over us, I am afraid neither of us got much rest. We were up betimes in the morning to find mountain and vale gleaming white under a thin covering of snow. But the sun shone brilliantly and as we scrunched, scrunched over nature's frozen carpet, not a breath of wind stirred. Inwardly praying that these conditions would continue, we made towards the river thinking that if there were any geese in the vicinity they would be there. Ravens (*Corvus corax tibetanus*) and Red-billed Choughs (*Pyrrhocorax pyrrhocorax*) were everywhere conspicuous in their jet black plumage against nature's snow-white back-ground. The latter were present in great numbers, some on bare patches in the fields, others circ ing and wheeling high overhead in the cold thin Tibetan air. One wonders what these birds find to feed upon in winter. Their diet must be almost entirely vegetarian for grub and insect life must be hard to come by when winter lays its iron grip on the land.

The Black-rumped Magpie (*Pica pica bottanensis*) was another very conspicuous bird for poplars, willows and buckthorn trees are plentiful around Dongtse. We had seen a flock of thirty or more of these birds the previous evening winging their way with laboured flight back from the fields to their roosting quarters near the village. Their huge massive nests were to be seen everywhere in the bare leafless trees.

They have the usually harsh corvine call of their tribe, but in addition, a note so similar to the 'scape' of a rising snipe, that I have been deceived time and again by its utterance.

We must have walked and ridden seven or eight miles that morning without seeing a single goose. They all seemed to have disappeared

and only a few Brahminy and Black-necked Crane were visible. We did indeed add another crane to our bag, but it was not until we had followed the Nyang-Chu river for three hours in the Shigatse direction that we encountered geese. Then we stumbled on a large flock feeding in a barley field. We had but little difficulty in getting within range and dropped no fewer than eight birds with four barrels. This was shooting for the pot with a vengeance, but more slaughter was to follow. After having missed a couple of teal and scared the life out of a female goosander, we found another flock of geese sunning themselves on the river bank, and four more birds added to the bag.

It was now noon and we were twenty miles from Gyantse, so we turned to the right about and made for Dongtse as quickly as possible.

Here we hired a mule to carry our bag which by this time weighed well over a maund, and then set out for home following the river as we went. Our luck was in. We had not gone far before a flock of twenty geese came high over us and two were raked out of the sky in great style. After this a flock of fifteen mallard were met with, five being added to our already heavy bag. The remainder did not go far and were marked down, and three more paid toll before the rest wisely disappeared.

Towards sunset four more geese were discovered feeding in a barley field, and these provided a very satisfactory ending to our shoot. Two birds were accounted for as they rose, and then the remaining two, missing their companious, circled round and paid the penalty for their devotion.

This brought our shoot to a close, and in the dusk we made the most rapid progress we could towards Gyantse. The cold became intense as darkness fell, and the temperature seemed to drop a degree every minute.

Our hands and feet became so numbed as we jogged along on our tired ponies that we had frequently to dismount and walk in order to rouse the circulation. We reached Gyantse at last in the dark, cold and tired, but several hot cups of tea and a warm fire soon revived us. Then we inspected the bag: twenty-two geese, eight mallard, two crane and a solitary snipe—a full mule load of shikar, which would provide excellent fare in the cold-storage atmosphere of Tibet for many a long day.

Sitting round the fire that night toasting absent friends, we saw the Old Year out and the New Year in, vowing Tibet was the finest country in the world, and that we on the 'world's white roof-tree', were the most fortunate of beings.

THE DUGONG OR SEA COW
(*HALICORE DUGONG*)

BY

S. H. PRATER, C.M.Z.S.,

Curator, Bombay Natural History Society

(*With four plates*)

The accompanying photograph illustrates a family of dugongs captured near Haramil Island in the Red Sea in July, 1905 by Captain John Kahu of the cargo steamer S. S. *Samshon.*

Captain Kahu first saw, what he took to be three human beings standing waist deep in the water. Mistaking them for the survivors of some wreck, he signalled to them and steered his ship in their direction ; to his surprise they appeared to elude his efforts at rescue and presently diving under the surface of the water disappeared from view. Fifteen minutes or so later they rose to the surface again. The skipper, now convinced that he was dealing with nothing human and something which he believed to be quite unusual, fired at the largest of the three and succeeded in wounding it in the neck. The wounded beast swam for a neighbouring island closely followed by its two companions, all three eventually landing and coming to rest on its rocky shore. The wounded animal, a bull dugong, was easily captured and offered little resistance when being secured with ropes. Its mate, a cow dugong with her calf, was as easily taken. The female dugong is said to be remarkable for the tenacity she displays in remaining by her young even under conditions of danger, so that when a young dugong is caught there is little difficulty in capturing the mother. Steller, the German naturalist, who discovered the now extinct giant Sea Cow or Rhytina on Behring Island, notes the great attachment displayed by these animals to each other so that when one was harpooned the others made great attempts to rescue it. The cow dugong in the present instance ' offered no resistance but clung desperately to her calf '.

The three captives were placed in a large tank on board and were fed with fish! The baby was suckled by the mother during the period of her captivity.

They lived within the narrow limits of the tank for two months, at the end of which the bull dugong died, his wound, the unnatural diet—dugongs are purely herbivorous and feed exclusively on sea grasses and other marine plants—and the limited area of his confinement were probably the contributory causes.

The cow dugong lived a week longer than her mate during which period she was greatly distressed, seeking her absent partner continuously within the narrow limits of her prison. She refused all food and, what is more, deserted her baby whose death in consequence brought the tragedy to its conclusion.

Dugongs captured near Hamrham Island, Red Sea.

The following measurements supplied with the above note by Capt. Kahu give some idea of the proportions of these animals. The male taped 9 feet in total length; he had an extreme girth (region behind the flippers) of 5 feet 6 inches and scaled 325 lbs. The female was 8 feet long, 4 feet 9 inches in extreme girth and weighed 280 lbs.

The length of a dugong, from Kilakaria on the Indian shore of the Gulf of Manaar, measured by the late Dr. Annandale,[1] was 9 feet 6 inches. A specimen in the Colombo museum from Jaffna, Ceylon, measures 9 feet 4 inches in total length.

Dugongs and Manatees are representatives of a group or order of herbivorous aquatic mammals known as the Sirenia, an indication of their supposed mermaid-like appearance.

The Dugong (*Halicore dugong*), a term derived from its Malayan name *Duyong*, occurs among the islands and along the coasts of the Red Sea and further south along the east coast of Africa, the islands of Madagascar and of Mauritius, the Indian and Ceylonese shores of the Gulf of Manaar, the Andaman Islands and the islands of the Malayan region as far east as the northern shores of Australia. In Indian waters, Jerdon notes the occurrence of the dugong in the salt water inlets of south Malabar and the Konkan coast. A dugong's skull was presented to the Society's Museum in 1893, the carcase having been washed ashore on the Mandvi coast in Cutch. I have not been able to obtain any information regarding the present occurrence of the dugong on the West Coast of India. Mr. Shankar Narayan Pillai, late Superintendent of the Trivandrum Museum, could obtain no information of their present occurrence on the south Malabar coast. As regards the east coast of India, dugongs still appear to be found in small numbers on the Indian shore of the Gulf of Manaar and the neighbouring islands. Mr. Pillai tells me that inquiries made by him elicited the information that the *Kadalpūdrū* or 'sea-pig', the Tamil name for the dugong, is found occasionally round Daneshkodi and Rameswaram Island, between November and January. Dr. Annandale was told that at Kilakarai, a large port on the Indian shore of the Gulf, as many as 60 dugongs were caught in a year, but he thought the number exaggerated. A female dugong from Tuticorin was presented to the Madras Museum by Mr. James Hornell in 1910 and Dr. Sundra Raj, Director of Fisheries, Madras, records the capture of a dugong between Krusadai[2] and Koipadu islands about ten years ago. Mr. Edgar Thurston writes of carcases being thrown ashore at Pamban[3] island and of a living specimen being caught in the fishing nets off Pamban on the day after his arrival there. Writing of the distribution of the dugong on the coast of Ceylon, Emerson Tennent[4] says that they were found in large numbers from the Bay of Calpentyn on the west coast of Ceylon as far north

[1] *Journ. As. Soc., Beng.*, vol. i, 1905.
[2] *Littoral Fauna of Krusadai Island*, 1927.
[3] *Madras Gov. Mus. Bulletin No. 3, 1894.*
[4] *Nat. Hist. of Ceylon.*

as Adam's Bridge. At the present time Dr. Pearson tells me that dugongs are only found along the north coast of Ceylon between Manaar and Jaffna and on the stretch of coast in the vicinity of the Pearl Banks. The evidence I have been able to collect appears to indicate that the dugong is becoming increasingly rare in Indian coastal waters, and in Ceylon recommendations are to be put forward by Dr. Pearson, the Director of Fisheries, for its protection during a part of the year. Petit [1] has shown that dugongs which 20 years ago were quite common on the Madagascar coast and in the neighbouring islands, are now much more restricted in their distribution and are now not found but in small groups of 4 or 5 individuals.

The nearest existing relatives of the dugong are the manatees which inhabit the west coast and rivers of tropical Africa and the Atlantic seaboard of tropical and sub-tropical America as far north as the West Indies and Florida. Three species are recognized, the African Manatee (*Manatus senegalensis*), the American Manatee (*M. americanus*) and the Nailless Manatee (*M. inungis*).

While the dugongs are exclusively marine, the manatees ascend the rivers. The African Manatee has been met with in the Kibali River, more than 1,243 miles from the mouth of the Congo while the Nailless Manatee is said to have almost completely withdrawn to the upper reaches of the Amazon and the Orinoco.

A third genus, the Northern Sea-Cow (*Rhytina stelleri*) existed up to the close of the eighteenth century among the islands of the Behring Sea. It was on Behring Island that Steller, the German naturalist who accompanied Vitus Behring on his fateful voyage, discovered this monster sea-cow. Behring's vessel was wrecked on the island which bears his name, and during his long and enforced confinement Steller had the opportunity of discovering and observing the vast herds of sea-cows which browsed on the rank weeds which covered the shallow coastal waters of the island and the adjacent Cooper Island. Within a period of forty years 1742–1782 after their discovery, the giant sea-cow was totally exterminated through human agency, probably for the sake of its flesh and hide. An idea of its enormous size when compared with existing sea-cows can be gauged from the fact that the northern sea-cow attained a length of 25 to 32 feet and a girth of 19–20 feet and was estimated to weigh 8,000 lbs. According to Steller it took forty men with ropes to drag the body of one to land. Naturally these sluggish, and inoffensive Sirenians became an easy prey. The dugong and the manatee appear to be following in the wake of their extinct relative as they are hunted down for the flesh and hide and more especially for the blubber which lies immediately below the skin. The blubber yields a clear limpid oil of considerable value. That of a dugong weighing from 4–6 cwt. will on boiling down yield from 6–14 gallons of oil.[2] The oil has no unpleasant flavour, is odourless and is largely used as a substitute for codliver oil. Beneath the blubber is a layer of white fat very similar to pig's fat in appearance.

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[1] *Bull. Mem. Soc. Anthrop.*, Paris, 1923.

[2] Watts, *Dictionary of Economic Products*, 1890, vol. iii, p. 197.

The fat of the dugong is believed by the fisherfolk of the Ceylon coast to be efficacious in dysentry—it is administered in the form of a sweetmeat.[1] It is also used instead of *ghee* for cooking purposes. The same belief is held by the Bushmen of the coastal region of North-west Australia who consider the oil extracted from the fat of the dugong to have great medicinal properties. The Comorra islanders use powder made from the bones of a dugong, from the skull in particular, for curing ulcers. With the Mahorrais of Madagascar the powder is made from the last rib and is used in lung complaints, while powder made by crushing the tusks is administered to those who have transgressed the law by eating that which is 'tabou'. They use the fat from the head as a calmative in head or ear aches; while the fat of the body, mixed with rice, is taken as a laxative and is also prescribed for skin diseases and even leprosy. (Petit, 1923.)

Dugong meat, when roasted, is said to be indistinguishable from good but rather tough beef-steak. Like the flesh of the manatee, it keeps good for a considerable time and even in our hot climate will remain eatable for at least three days.[2] According to a recent writer in the *Illustrated London News*, in the sparsely inhabited parts of North-west Australia, where conditions are still primitive, salted dugong and turtles' eggs take the place of bacon and eggs on the domestic breakfast table. Dugong's flesh is held in much esteem by the Moslems in Ceylon and on the Indian coast, a dugong sold piece-meal, fetches on an average between twenty and thirty rupees. In the south-west of Madagascar the Vezos, an indigenous tribe, observe certain rites in eating the flesh of the dugong. The carcase is always cut up in secret. Strict silence is observed during the operation nor must one look at the animal which is disguised with cloths. It is 'tabou' to carry the meat into the village precincts and it must not be eaten from a plate or put into a vessel. These propitiatory rites are practised to ensure the success of future hunts. (Petit, 1923.)

Dugongs are caught by the fishermen in the Gulf of Manaar in wide-meshed nets and many of them are sent alive to Colombo by train.

The Bushman's method of capturing dugongs is by spearing. As he possesses no ropes he retains hold of the spear after making a thrust and plunges into the water after the animal. On the Madagascar coast and in the neighbouring islands, dugongs are hunted both with nets and with harpoons. The nets are placed vertically in the opening of a sand bank. One end of the net is fixed, the other free. The dugong, whose muzzle or flippers are enmeshed, soon becomes hopelessly entangled in his efforts to free himself and dies either from drowning or is finished off with a harpoon. When spearing dugong, there is always the possibility of the creature upsetting the boat in its attempts to escape and the Malagassy fishermen overcome the danger by roping several boats together the moment the harpoon is driven home. Among the

[1] Watts, *Dictionary of Economic Products*, 1890, vol. iii, p. 197.
[2] Annandale, *Journ. As. Soc. Bengal*, vol. i, 1905.

Vezos of Madagascar, the thrower of the harpoon must make quite sure of his aim; to allow the coveted prize to escape would presage dire misfortune and death to a member of his family. (Petit, 1923.)

The giant sea-cows of Behring Island offered the inducement of an abundant supply of fresh food to the various fur-hunting expeditions which wintered in those inhospitable regions, while sailing ships in those parts took in regular supplies of salted cow meat. Dugong and manatee bones are used to a limited extent while their hides are converted into leather. Rüppell has endeavoured to prove with much ingenuity that the Tabernacle built by the Israelites on their eventful journey from the shores of the Red Sea through the Desert of Sinai, was roofed with dugongs' skins.

He was also of opinion that the sandals of the women to which the Prophet Ezekiel refers (xiv. 10) were made of dugong skin. Cigarette holders are made of dugong tusks as also rosaries sold in Egypt. The rosaries have the additional virtue of facilitating child-birth and averting an evil fate!

Dugongs and manatees feed exclusively on aquatic plants and weeds upon which they browse beneath the surface of the water, exactly as herbivorous animal do on land.

In the Gulf of Manaar dugongs were said to feed exclusively on the green sea-grasses (*Phanerogams*) which, almost to the exclusion of sea-weeds, grow very abundantly in the shallows along the coasts and round the islands in the gulf. However, the stomach contents of a specimen examined by the late Dr. Annandale[1] contained large masses of marine algæ. This change in diet may be due to the reported change in the habits of the dugong in the Gulf of Manaar where they no longer appear to frequent the shallows in their accustomed herds. At the present time, according to the fishermen on the Indian coast, the only specimens they see along the shore are those which are sick or in some way disabled.[2]

In other regions where they are found, the diet of the dugong appears to consist mainly, if not exclusively, of Phanerogamous marine plants. Petit[3] writing of the food of the dugong in Madagascar says that they are very exclusive in their choice of food plants and that they subsist on a Phanerogamous herb, *Cymodacea* (*Diplanthera*) *australis* which the local people call 'Dugong grass'. He says that the presence of the dugong in those waters is absolutely bound up with the existence of this plant which is very common in the shallow coastal waters. He concludes that the 'algæ' on which they browse in the Red Sea according to Rüppel (1834) are probably the same species. In Australia the dugongs feed on the marine grasses *Halophila ovalis* and *Zostera capricornis* Asches, which like *C. australis* only grows on high banks 'in shallow water (Dexler and Freund[4]).

Edgar Thurston tells of a tradition among the fisherman of Pamban that a box of money was once found in the stomach of

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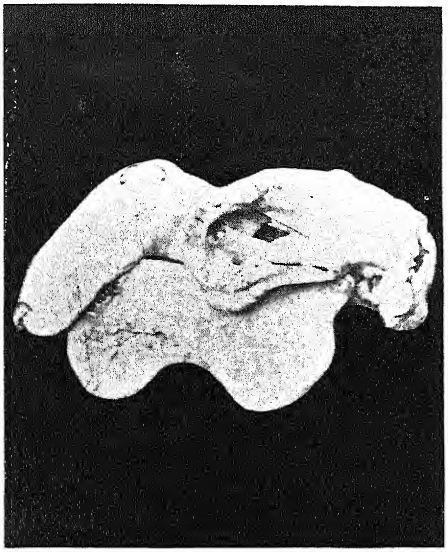
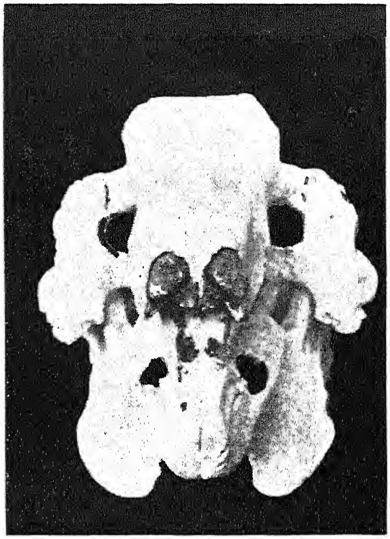
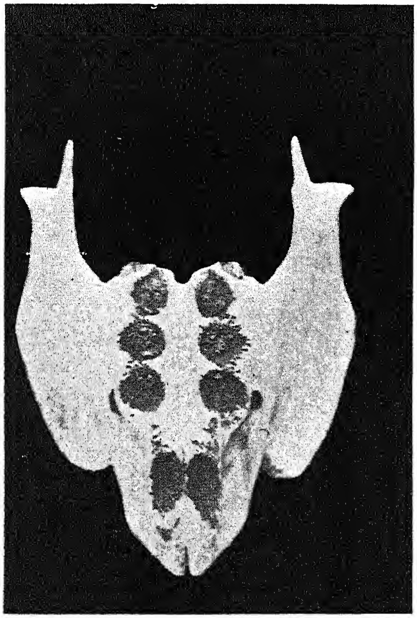
[1] Annandale, *Journ. As. Soc. Bengal*, vol. i, 1905.
[2] *Ibid.*
[3] *Bull. Mus Nat. Hist. Paris, 1924.*
[4] *Archiv. für Naturgsechite*, Bd. 1, 1906.



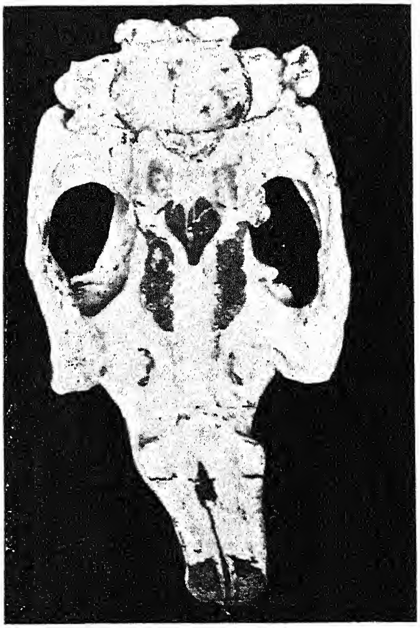
1. Side view of skull of a young Dugong showing downward deflection of the jaws.



2. Front view of skull of a female Dugong showing abortive tusks buried in their sockets.



3. Lower jaw of a young Dugong showing sockets of 8 rudimentary incisor teeth.



4. Ventral surface of upper jaw of a young Dugong. Details of its dentition are shown in Fig. 2, Plate IV.

a dugong and, as a result, an official was always invited to be present when a dugong was cut up to see that the laws governing the finding of treasure trove were in no way contravened! The same belief persists on the coast of Western India and when whales and other cetaceans are stranded they are usually opened up only after a *punch* or the legal number of witnesses have been summoned to attend the ceremony.

On the north-west coast of Australia, north of Broome, dugongs still feed in herds, going slowly and leisurely from one feeding ground to another. The coast here is the centre of the pearling industry. It is very rugged and there are innumerable and frequent reefs, where the tides rip and swirl in dangerous currents that pile up the water and make great whirl-pools. Round these islands and among these reefs there are big sea-meadows where the dugongs feed.

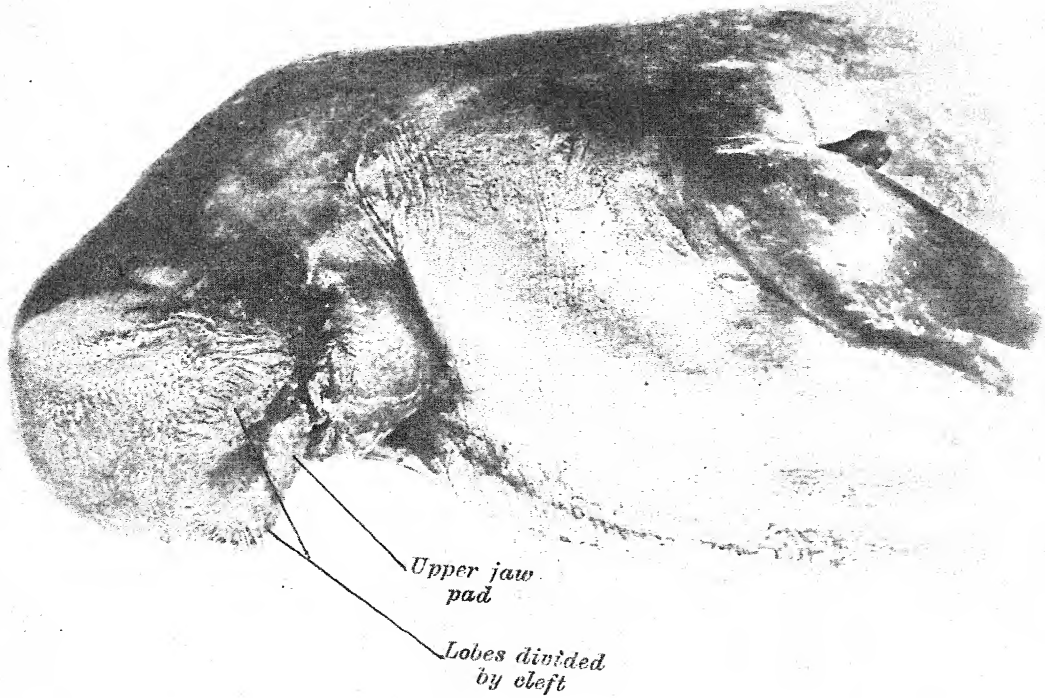
Unlike the manatees the dugongs are essentialy marine animals or more correctly they form part of the coastal fauna. They do not swim up the rivers but keep to the shallow bays, inlets and estuaries along the coasts, visiting their marine pastures at flood tide and going out with the ebb. While browsing the dugong roots up its food with side-long twists of its head, coming to the surface to breathe at short intervals. Observers are not in agreement as to the length of time which elapses between respirations. Dexler and Freund (1906) consider the maximum interval is 2½ minutes. Rüppell (1834) puts it at a minute, Klunziger (1870) at 10 minutes while Semon says that it was from 3 to 5 minutes in a male observed by him. The sounds made by the dugong while breathing are audible at a considerable distance. Two distinct sounds are recognized, one caused by the intake and the other by the expulsion of air. Beyond these sounds the dugong is believed to have no particular cry. Petit comments on the curious tracks left by dugongs when feeding. They are compared to the tracks of a waggon. The furrows are clean and distinct the grass being up-rooted through their entire length.

The skeleton of the Sirenians is remarkable for the massiveness and density of the bones, especially of the skull and the ribs, their great weight adding to the specific gravity of these cumbrous and slow moving animals aids them in keeping to the bottom of the shallows where they browse. Another adaptation in structure designed to aid these sea-cows when feeding is the downward bend and prolongation of the bones of the upper and lower jaws, a character particularly noticeable in the skull of the dugong, which brings the creature's mouth in ready contact with its food as the animal lies prone on the sea bottom. It has been pointed out that peculiar character in the jaws of dugong is naturally advantageous to a heavy and short-necked animal which browses in shallow water. (*Plate II. Fig. 1*). It is interesting to note in this connection that the downward deflection of the jaws is much more pronounced in the skull of an immature dugong in our collection than in that of an old female. The skull of the manatee displays the same character to a limited extent. While grazing the manatee gathers up its food mainly with its thick prehensile upper lip. The

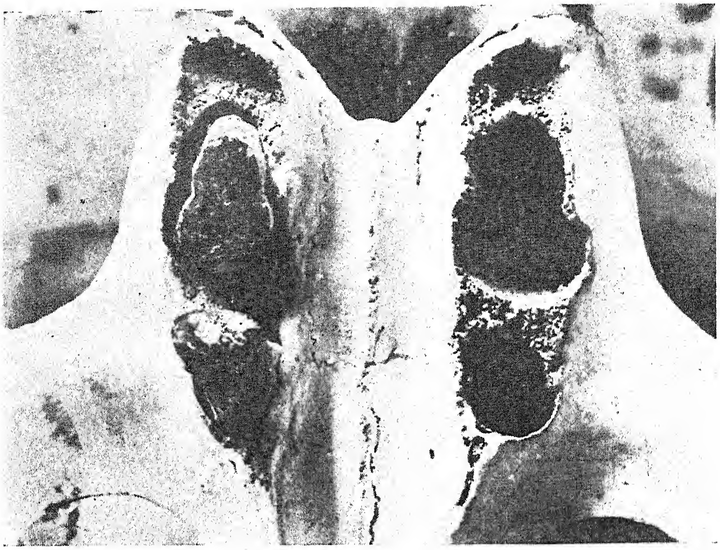
upper lip is divided by a deep cleft which is narrowed and widened at will. The two lobes of the lip forming the cleft, are covered with stiff bristles whose points meet together like the opposing ends of a pair of forceps and gather up the food into its mouth.

The peculiar cleft lips of the manatee are not developed to the same extent in the dugong. On the underside of the flabby extension of the upper lip of this animal, there are two ridges, covered with an armature of bristles, described as being similar to but blunter than the quills of a porcupine (*Plate III*). These two ridges take the place of the heavy lobes with which the manatee crops his food. In the dugong these two ridges are not capable of any great degree of motion or separation and could not, it is believed, very effectively serve the same purpose. When browsing, the dugong probably grasps and up-roots weeds with the fleshy pad of his upper lip used in conjunction with the lower lip. It is remarkable however, that the dugong in the stage before birth shows much less deviation from and a much closer resemblance to the manatee in the structure of its upper lip. From this it is assumed, that the extraordinary mechanism of the lip of the manatee was once possessed but has since been lost by the dugong, and that the dugong is a stage in advance of the manatee.

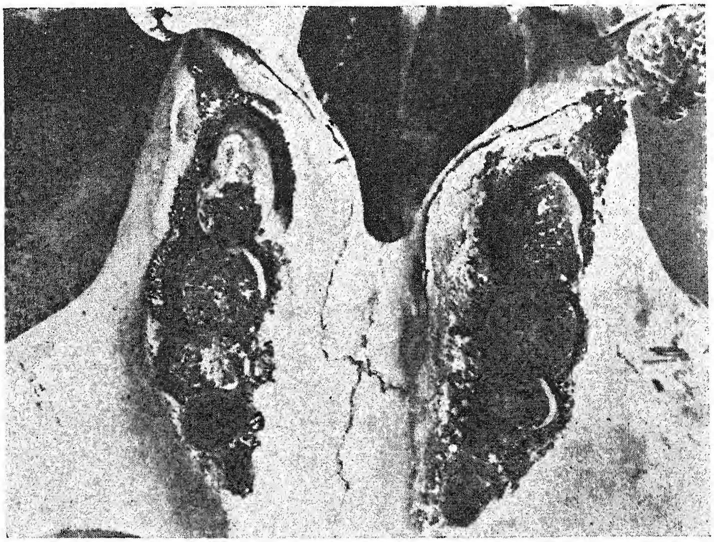
The teeth of both manatee and dugong present a remarkable degree of specialization, or in other words a remarkable deviation from the normal type or standard of teeth obtaining in mammals. The standard number of teeth in mammals is 44 as exemplified in the pig or the wild boar to whose dentition the teeth of all other mammals may be referred for comparison. Each half of the jaws of a wild boar carries 11 teeth:—3 incisor or cutting teeth in front, succeeded by a great cannine (the tusk) which is followed by 7 molars or grinding teeth. In dugongs and manatees the canines are wanting, the front teeth being separated from the molar teeth by a wide gap, a character suggestive of the rodents. A remarkable feature in the dentition of the manatee is the great increase in the number of grinding-teeth developed by the animal in the course of its existence. It is said to have as many as 44 molar teeth, i.e., eleven in each half of its jaw. All these are not however present together ; there are rarely more than 5 or 6 in place at one time, as the anterior grinders are shed before the posterior ones come into position. As these grinding teeth increase in size in the order of their succession, by comparison of the jaws of individuals of varying ages it has been possible to deduce from the size and character of a tooth, the number of teeth that may have preceded it and thus to arrive at the total number of molar teeth developed by the animal in the course of its life. This replacement of teeth is a provision made for the maintenance of the grinding machinery in good working order throughout the animal's extistence. There appears to be a continuous forward motion of the whole row of molar teeth ; increasingly large posterior molars being developed and moving forward to take the place of the older and consequently more worn ones in front. As the partitions or septa between these teeth are very porus it would seem that they are easily removed while the teeth move



THE DUGONG (*Halicore dugong*).
Photographed from a specimen in the Colombo Museum to show the head and mouth parts.



1. Upper jaw of an old female Dugong. All trace of the anterior molar teeth have been obliterated by the growth and advance of the 2 large posterior molars.



2. Upper jaw of a young Dugong showing evidence of 5 molar teeth.

forward, guided by the dense bony walls of the jaw bone. As no trace or suggestion of a continuous succession of teeth is seen in the closely allied fossil Sirenians, regarded as the ancestors of the manatee, it is presumed that the indefinite supply of molar teeth in the manatee is a new development evolved to make up for the rapid wear and tear of the grinding teeth in an animal living on sea-weed and water-weeds, generally much intermixed with sand.

The gradual displacement of the smaller teeth by the advance of larger teeth is a peculiarity of dentition which has become established and attains it maximum in the elephant. But in the elephant each new molar developed in the jaws is larger and more complex in structure than the one which preceded it. The molar tooth of an elephant is built up of a series of plates, the upper edges of which form ridges, plainly visible across the crown of the molar. The first molar shed by an elephant shows only 4 of these ridges, succeeding ones show an increasingly greater number, while the sixth and last one to be developed shows as many as 27. This not only indicates that these molars increase in size and complexity of structure, but it renders it possible to tell by the number of ridges exhibited by an elephant's molar, the position it held in the sequence of teeth and the number of molar teeth developed by the animal during its life. The dugong has a smaller series of molar teeth than the manatee and does not develop more than 20 grinding teeth in the course of its life, viz., 5 in each side of each jaw. This is the condition of the teeth in the skull of a young dugong in the Society's collection. All 5 teeth are not however present in the jaws at the same time, as the first or foremost molar tooth in the jaws is shed before the fifth or hindmost tooth cuts the gum. In the skull to which I refer the existence of these anterior molar teeth is indicated by their sockets which are still evident, though partly filled up by the growth of bony matter from the jaws. (*Plate IV*) the three anterior molars in each jaw are shed early in life; and their place is taken by the advance from behind of the two much larger posterior molars which are the permanent teeth of the dugong. This is well illustrated in the skull of an old female dugong which we have (*Plate IV*). In this skull there are only two molar teeth on each side of the upper jaw, the largest of these measures $1\frac{3}{16}$ of an inch along the long axis of its crown, while the corresponding molar in a young animal is a little over half an inch. These two molars now occupy the entire space in the jaw bones. All trace of the first, second and third molars which existed at an earlier stage have been obliterated. On the left side of the lower jaw only one molar tooth remains; the first, second, third, and even the fourth has been lost. The socket of the fourth molar is however still evident though much reduced in size by the growth of bony matter. This indicates that the dugong starts life with a complement of 20 molar teeth in its jaws, that 12 of these i.e., the three anterior molars in each jaw, are shed to make room for the advance and growth of the two posterior ones in each jaw so that in the adult stage only 8 molar teeth remain and even some of these, as seen in the skull before us, may be lost.

Thus the great number of grinding teeth possessed by the manatee is reduced to a considerable extent in the dugong and this degeneration of the dentition culminates in the Rhytina which was quite toothless.

From the unbruised and perfect condition of the sea-weed found in the stomach of a dugong, and from the fact that its jaws are articulated in a manner which permits of little, if any lateral movement and for other reasons connected with the structure of its mouth parts, Dr. Annandale[1] concluded that the grinding teeth of the dugong had little function beyond crushing the chalky and other growths brushed off its food by the array of bristles growing on the horny plates which cover the anterior portion of its palate and lower jaw. The scratches made on the surface of the crowns of the posterior molars in the skull of the young dugong in our collection, obviously by the grinding of gritty matter, are, however, all lateral that is, they run crosswise on the surface of the crowns which suggests that the jaws must have some lateral movement. Petit[2] also records that the stomach contents of dugongs examined at Madagascar showed that the plants eaten by them were swallowed whole and intact. There was also no trace of sand or foreign matter; another point already noted by Annandale. Like Annandale, Dexler and Freund concluded that the dugong brushes or washes the herbs which it plucks before swallowing them.

A striking feature in the anterior molar teeth of the same skull is that they have retained, to a more or less perfect extent, the cusps on their crowns, while in the posterior molars, which are developed subsequently the crowns are worn quite smooth. This seems to suggest that the grinding of the waste matter is carried out mainly by the posterior molars and that the temporary anterior ones have little or no function.

The manatee has two upper and two lower incisor teeth but these are rudimentary and are buried beneath the horny plates which cover the front of its palate and lower jaw. In the dugong the incisor teeth in the upper jaw are developed in the males to form a pair of tusks. These tusks in the bulls project beyond the mouth in a forward and downward direction. In their structure they recall the incisor teeth of rodents. In all gnawing animals the front, or cutting teeth, are formed of soft dentine or ivory, only the front and side of the tooth being faced with an investment or coating of intensely hard enamel; thus while gnawing the comparatively softer dentine is constantly being worn down while the hard enamel front of the tooth persists and maintains the sharp chisel-shaped edge. Exactly the same principle is followed in the making of a chisel which is faced with tempered steel and is backed with soft iron to preserve the sharp cutting edge by the persistence of the harder and the wearing away of the softer material.

In the female dugong the growth of these tusks is arrested before they cut the gum and they remain buried in their sockets throughout life (*Plate II*, *Fig. 2*.) The same arrested growth and concealment

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[1] Annandale, *Journ. As. Soc. Bengal*, vol. i, 1905.
[2] *Bull. Mus. Nat. Hist. Paris*, *1924*

of the upper tusks in the female and their development and projection in the male is manifested on a much greater scale in the Narwhal, the males of which carry a tusk which protrudes from the upper jaw and continues to grow till it acquires a length of 9–10 feet, forming the famous 'horn' which so long excited the wonder and curiosity of the older naturalists. In the female Narwhal the incisor teeth which give rise to the tusk of the male do not develop, remaining concealed in the substance of the jaws.

In addition to its permanent tusks, the young dugong carries a smaller pair of upper incisor teeth which are shed early in life. The sockets of these tusks are plainly visible in the skull of the young dugong to which I have referred. They are situated above those of the permanent tusks, and their character suggests that both pairs must at one time have been co-existent. In the skull of the old dugong no trace of the sockets remains.

From the fact that the tusks are only manifested in the males, it has been concluded that they could not play an important part in securing the animal's food. The scarred condition of a male examined by Dr. Annandale led him to believe that the males fight with their tusks at the breeding season. Mons. M. G. Petit[1] has recently drawn attention to the scarred condition of a female dugong examined by him at Madagascar. Her back, flanks and undersurface showed a number of scars, some of them quite fresh, others healed. The explanation offered by the local fishermen was that the dugongs received these scars while turning about in the water from projecting masses of coral, from oyster-covered rocks and from sharp-edged pinna shells which lie half buried in the sand among the sea-grasses on which they feed.

Incisor teeth are present in the lower jaw of the dugong. In the photograph of the skull of a young dugong which is published the sockets of these incisors are plainly visible in the deflected part of the lower jaw (*Plate II*). There are 8 of these sockets, 4 in each half of the jaw. Distorted teeth may be found in these sockets in young animals, but they are rapidly absorbed or lost. The same phenomenon is seen in the whale-bone whales; in the adult condition these whales are toothless, but prior to birth the margins of both upper and lower jaws are covered with a series of rudimentary teeth which are speedily shed or absorbed. The development of tusks in the lower jaw of the dugong would have given its skull a marked resemblance to the extinct Dinotherium or 'terrible animal' which, like the Sirenia, was probably aquatic and which carried a pair of huge incisors projecting downward like great tusks from its lower jaw. When the skull of this animal was first discovered, many naturalists believed it to be some gigantic manatee or sea-cow and concluded that its tusks were used for tearing food from the bottom of the rivers and for anchoring itself on banks just as a walrus uses its tusks for digging up clams and climbing out upon the ice.

Steller's Sea-Cow was toothless but its palate and the front of its lower jaws were covered with dense strongly-ridged horny plates beset with stiff bristles. These horny plates are possessed

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[1] Petit. *Bull. de Mus. Nat. D'Hist. Nat.* Paris, No. 5, 1927.

also by manatees and dugongs. While feeding, the sea-grasses and marine plants cropped up between the dugong's lips pass into its mouth between these horny plates which are furnished with bundles of stiff hairs, arranged like the bristles in a scrubbing brush. It is believed that the function of these bristles[1] is to clean or scrub away from the surface of the weeds any chalky or other growths which invest it. The weed is then apparently swallowed whole, and it is assumed the foreign matter brushed from its surface is ground down by the molar teeth of the animal.

Externally, the dugong and the manatee are heavy, clumsily built animals with flattened bellies and rounded backs.

The colouring of the dugong is variable. An animal described by Dr. Annandale was dull brownish-grey on the back, fading to pure grey on the sides and to dirty flesh colour on the belly. Its skin was not wrinkled like that of the manatee, but was smooth, though it lacked the polished oily appearance of so many of the whales and dolphins. The whole trunk, limbs and tail showed a covering of fine hairs which gave the skin a prickly appearance in certain lights. In a specimen examined by him in Madagascar, Petit states that its skin was furrowed with fine wrinkles particularly visible on top of the head, between the eyes and the nostrils.

The head of a dugong is remarkable. Its most conspicuous feature is the enormous extension of the upper lip in the form of a broad, flattened, horse-shoe-shaped disc which overlaps the sides of its mouth. The underside of this disc is covered with fine sensory hairs. At its base, separated by a cleft, are the two great ridges armed with heavy bristles, which are comparable to the spine-invested lobes with which the manatee crops its food. Beyond these ridges is as smooth flabby tongue-shaped pad which conceals the mouth and projects well over the lower jaw (*Plate IV*). In the bull dugong the tusks protrude through the skin of this pad and not through the mouth, as is generally believed. The nostrils—a pair of crescent-shaped slits—are placed well over the pendulous muzzle. On the upper surface of the head, two very minute openings serve the purpose of ears. Contrary to the observations of Dexler and Freund (1906) who consider the sight of the dugong to be feeble, the Malagasy fisherman, declare that it has excellent powers of sight both by day and by night. They believe however that its sense of hearing is much more acute ; the clashing of an oar against the side of a boat, even at a considerable distance, will put these sea-cows to flight. (Petit, 1923). The beady black eyes of the dugong are sunk well under its fleshy brows. The presence of glands in connection with the eyes may, it is said, furnish some foundation for the belief current among the Malays and Malagasy fishermen that the dugong sheds tears when it is captured. Their belief is corroborated in some notes on a recently captured dugong made by Mr. Deraniyagala of the Colombo Museum, forwarded to me by Dr. Pearson. Tears were observed constantly flowing from the

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[1] Annandale, *Journ. As. Soc. Bengal*, vol. i, 1905.

creature's eyes. The sclerotic or outer coating of the eye-ball secretes an abundant mucous which is collected by Malay fishermen as a love charm. Only the tears of young dugongs are collected, as with age the charm is said to loose its potency (Raffles).

Neither the dugong nor the manatee possess hindlimbs. In the manatee, the only indication of hindlimbs are two small splint bones, embedded in the flesh at some distance from the vertebral column. These are believed to be the remains of the thigh bones. In the dugong the vestiges of the degenerate pelvis appear to be made up of three and not two bones as is generally supposed.

The fore limbs of the sea-cows bear a general resemblance to the flippers of a whale but in the Sirenia the fingers, as in terrestial animals, are generally composed of three well-jointed bones, though in the dugong it has been found that not only does the flipper vary greatly in size, even in fully adult animals, but the bones of the hand[1] vary in number and in development. The first digit is always less well developed than the others; in some individuals it consists of a single bone, in others it may be made up of two bones. Similar variations are seen in the bones of the palm and the wrist. In the hand or flipper of a whale, the phalanges of the fingers have been multiplied as a result of which the length of the fin and its efficiency as a paddle is considerably increased. Rudimentary nails have been discovered in the cetacean hand but these are never functionally developed. In the hand of the dugong the nails have disappeared; in that of the manatee the disappearance is incomplete. The small manatee of the Amazon has no nails on its flippers, except for traces, which may possibly be sèen with the microscope. The African Manatee and the American Manatee have the flippers furnished with nails but not every finger is so armed. When swimming, the flippers are used mainly as balancing organs and in turning. In a captive manatee it was observed that the extreme margins of the flippers may be used for introducing food into the mouth. The creature also used its fore limbs in moving along the bottom of the pond when its tail could not be brought into play to any extent. Neither the dugong nor the manatee willingly quit the water; on land they are said to be incapable of movement being unable to advance or recede.

In movement and mode of progression in the water these Sirenians resemble the whales and the porpoises. The tail is the principal organ of propulsion. The tail while swimming is not moved from side to side—it has not the lateral movement of a fish—but as in the dolphins and whales it acts from up downwards with a vertical, at times with a glancing stroke dependant on the position of the body. The posterior portion of the body bends in harmony with the movements of the tail. This flexibility is explained by the fact that, as in the cetacea, none of the vertebræ in the lower region of the spinal column unite to form a sacrum or that part of the vertebral column which is distinctly connected with the pelvis. A solid immovable structure in this part of the backbone would be a serious disadvantage to a swimming animal.

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[1] Annandale, *Rec. Ind. Mus.*, vol. i, p. 79, 1907.

The absence of or the degeneracy of the pelvic bones gives the hind region of the spinal column its resemblance to that of a fish and accounts for its flexibility.

The Sirenia, it will be seen, both in their internal and external structure present many affinities to the whales. It is believed that these affinities are purely of a convergent nature. They have been evolved as a result of an aquatic life in two otherwise distant groups of animals.

Both the dugong and the manatee produce a single young at birth which they tend with assiduous care. Tradition maintains that the dugong holds her baby to her breast between her flippers when suckling it or otherwise; but it has been pointed out that even if the baby dugong were able to take refuge under the breast of its mother it is not apparent how it could possibly be embraced by the comparatively short flippers of its parent.[1] According to Langkavel (1896) the baby dugong supports itself on the back of its mother. This is also the opinion of the Malagasy fishermen. The teats are placed almost under the flippers in the region which would correspond to the armpit in a human body.

The habit of rising half out of the water combined with the rude resemblance under these circumstances to a human being gave rise among the earlier voyagers to India to the stories of legendary beings, half human and half fish, in allusion to which the name Sirenia was bestowed on these animals. Megasthenes records the existence of a creature in the ocean near Ceylon (Taprobane) with the aspect of a woman, while the Portuguese and Spaniards gave the dugong a name signifying Woman-fish. Again the hairy lips of the dugong, may, with a little imagination, have prompted Aelian's marvellous description of fishes with heads of lions, panthers and rams inhabiting the seas of Ceylon, for it is significant that the Dutch call the dugong the 'Little Bearded Man'. Petit endeavours to show that the mermaid of the Malagasy legend which recounts the loves of a fisherman and a siren of the sea originated in the dugong. He traces a connection between the name of the legend, i.e., '*Ampella Mannaissa*', meaning, 'a woman who has gills' and the belief commonly held by Madagascar fisher folk that the dugong breathes through gills like a fish. The Comorra fishermen further attribute a human origin to the dugong. Legendary belief accounts for their origin as the result of the guilty love of a brother for his sister. The couple were punished by being transformed into fishes in human form. Finally M. Petit concludes from certain beliefs held by the Malagasy fishermen to-day, from the rites performed by them when dugongs are captured and from the oath that the Mahorrai fisherman must take before he can sell the flesh of a dugong in the local market, wherein he foreswears any unnatural relationship between himself and his captive, that the fabled loves of human beings for the sirens of the sea may not have had an entirely legendary foundation. He points out that it is not only primitive people who connect the dugong with the mermaid but

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[1] Petit, *Bull. de. Mus. Nat. D'Hist. Nat. Paris*, No. 5, 1927.

that the belief is also current in civilized countries. It is possible that the dugongs of the Madagascar seas have given rise to the Malagasy myth and if so, has the human origin ascribed to them had its parallel in the origin of the sirens of Greek Mythology ?

The dugong may have been the basis of some of the mermaid stories, but fabled human beings half human half fish are as common in temperate as in tropical seas. The fish tail which in popular belief invariably forms an indispensable part of a mermaid is really of no special importance, for your true Teutonic mermaid had no fish tail; while the symbolic appendage occurs in the mythologies of so many countries where these Sirenians do not exist that it is impossible to discover a clue to the origin of the belief.

What is the origin of the Sirenia ? It is assumed that the sea-cows, like other marine mammals, originated from land or terrestrial mammals. An assumption of this nature is arrived at by three methods or processes of investigation. The Doctrine of Descent, now generally accepted by Biologists, looks upon an animal not as a distinct creation but as being derived by a natural process of descent from pre-existing species ; exactly as the various breeds of domestic cattle of Asia are believed to be the descendants of the Tsaine—the wild bull of the Burmese and Malayan forests. In the difficult and almost hopeless task of tracing the descent of an animal and fixing its true relationship, the zoologist is helped by the study of the remains of extinct forms which have been preserved in the strata of the earth, secondly by the generally accepted theory that the changes undergone by an animal during its development in the embryonic stages forms an epitome or condensation of the changes by which in the course of long ages it has been evolved from ancestral types. We have seen how the dense coat of rudimentary hairs, discovered in the fœtus of a manatee, has led to the assumption that the manatee is the descendant of an animal which was as furry as a seal. Finally a comparative study of the organs of adult animals helps to furnish evidence in establishing their relationship and derivation.

The remains of extinct sea-cows offer us important and significant clues in tracing the origin and descent of these marine mammals. Unlike the whales, they were dwellers on the coasts and their remains are found in abundance in the marine Tertiary deposits of Europe. The profusion of the remains discovered in this area has provided the assumption that the Mediterranean was the original home of the Sirenia. They appear to have arisen in the middle Eocene and until the Pliocene were abundant along the coasts of Europe. From thence it is believed the ancestors of the dugongs migrated eastward and those of the manatee westward[1] which theory may explain why the manatees are now confined to the seaboards of the South Atlantic, while the dugongs are limited to the coastal waters of the Indian Ocean. The past distribution of the sea-cows and their present exclusive confinement to the tropical regions of the earth adds one more proof to the now well-established

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[1] Abel, *Ann. Rept. Smith. Inst.*, 1908.

fact that throughout most of the Tertiary era the climate of northern latitudes was very much warmer than it is now; it must have been almost tropical. The most primitive sea-cow known to us is the Porastomus of the Eocene, with whom appeared a second genus which received the poetic name of Eotherium or 'animal of the dawn.' The salient character of these primitive sea-cows lies in their possession of teeth which show little deviation from the standard type of teeth in mammals. The Porastoma had a complete and fully differentiated dentition of incisor, canine and molar teeth, while its skull was characterized by the complete absence of the downard deflection of the jaws which is so distinctive in all the sea-cows which followed it. A second important fact brought to light by the examination of the remains of these primitive sea-cows is that they possessed functional hind limbs. The complete pelvis of the Eotherium with its well formed acetabulum or socket for the articulation of the femur or thigh bone suggests that this ancient sea-cow still retained a functional hind limb. In the sea-cows of the upper middle Eocene, the hind limbs had already become functionless. The pelvis had already degenerated and its component bones, the ilium, the ischium and the pubis had more or less fused. By a study of these later forms we can trace step by step the course through which the degeneration of the pelvis and the femur has passed. The pubis gradually becomes smaller and disappears entirely in the Metaxytherium, a sea-cow from the Miocene of Austria; while the acetabular cavity for the articulation of the thigh bone already becomes smaller and rudimentary in the Halitherium of the Oligocene. Finally only a long rod of bone remains, the upper part of which consists of the ilium and the lower the ischium as in the extinct sea-cow or Rhytina. The manatee still retains the fragmentary rudiments of the pelvis while in the dugong the pelvic girdle is represented by three small bones. Evidences of this nature indicate the origin of the sea-cows from four-limbed mammals. Finally a comparison of the structure of primitive sea-cows with those of primitive proboscidians, a class of animals to which the elephants belong, appears to indicate an affinity or relationship between the ancestral stocks of these two apparently distinct groups of animals. Similarities in the structure of the brain, and to some extent of the pelvis, have been discovered in the ancestral forms of Proboscidia and Sirenia. Resemblances have also been traced in their living representatives. In both groups there is a similarity in the position of the teats and in the structure of the heart. Again, the molar teeth of the sea-cows are essentially the same as those of the early proboscidians. The mode of succession of these teeth also reveals a certain similarity. Though specialization in the sea-cows has resulted mainly, as in the manatee, in a great increase in the number of grinding teeth, while in the elephant the increasing complexity of their structure is more marked.

Comparisons and deductions of this nature may to a certain extent indicate the origin of dugongs and manatees from terrestrial mammals but it cannot be said that they succeed in definitely establishing such an origin.

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FURTHER NOTES AND DESCRIPTIONS OF BOMBAY SHORE FISHES

BY

HENRY W. FOWLER

Of the Academy of Natural Sciences of Philadelphia

(*With two plates*)

The second instalment of Dr. F. Hallberg's collection of Indian fishes contains the material reported in the present paper. They are labelled as having been obtained at Bombay and most also with the additional designation of Back Bay. These specimens comprise 175 specimens, representing 89 species, of which I describe as new :

Pseudochromis spencei.
Pomacentrus prateri.

ORECTOLOBIDÆ

Stegostoma tigrinum (Forster).

Depth $4\frac{1}{2}$; head $3\frac{3}{5}$, width 1. Snout $1\frac{3}{4}$ in head ; eye 10, 7 in snout, $9\frac{3}{4}$ in interorbital ; mouth width $3\frac{2}{5}$, with short labial folds at angles and with preoral upper fold followed by hind narial flap ; teeth small, tricuspid, about 20 rows in each jaw ; interorbital $1\frac{1}{8}$ in head, broadly convex. Spiracle short vertical slit about half eye-diameter behind eye and length $1\frac{1}{2}$ in eye. Scales with median keel and 1 or 2 laterals each side, all ending in short points. First dorsal inserted little before ventral, length $1\frac{1}{4}$ in head ; second dorsal before anal, length $1\frac{2}{3}$; anal $2\frac{1}{10}$; ventral $1\frac{4}{5}$; pectoral $3\frac{7}{8}$ to caudal base ; caudal very slightly less than rest of body.

Brown largely, under surface of head and abdomen uniform whitish. Over back 12 cross bands of little deeper brown, each bordered broadly by blackish, between end of snout and first dorsal with first 8 louped variably as pairs ; on rest of body and tail about 25 dark cross bands, of which half a dozen on tail louped or paired. Whole lower side of body and tail, also anal and upper surfaces of paired fins, with dark or blackish spots, largest but little larger than eye.

One 788 mm. For comparison I have examined two from the Philippines, 325 to 356 mm. The larger shows :

Snout $1\frac{2}{3}$ in head ; eye $10\frac{1}{2}$, 7 in snout, 9 in interorbital ; mouth width $2\frac{1}{2}$; teeth in 23 rows in each jaw ; interorbital $1\frac{1}{3}$ in head, convexly elevated. First dorsal length $1\frac{1}{2}$; second dorsal length $2\frac{3}{5}$; pectoral $1\frac{1}{8}$, width $1\frac{1}{4}$ its length ; ventral 2 ; caudal slightly greater than rest of body. Back and sides brown, 8 transverse buff bands on head and body and 13 on tail ; first band across occiput down on pectoral bases, likewise second band ; on tail bands divide to form lower series. Small pale spot in middle of interorbital. Belly and under surface white.

Chiloscyllium griseum, Müller and Henle.

Depth $8\frac{3}{4}$ to $9\frac{3}{5}$, to origin of subcaudal lobe ; head $4\frac{4}{5}$ to 5, width $1\frac{1}{8}$. Snout 2 in head ; eye $3\frac{3}{4}$ to 5 in snout, $2\frac{3}{4}$ to 3 in interorbital ; mouth width $2\frac{1}{2}$ to $2\frac{3}{4}$ in head, with short, deep, labial folds at angles leaving broad, adnate, lower fold ; teeth in 26 to 30 rows in each jaw, each as strong, triangular, median cusp ; interorbital $2\frac{3}{4}$ to 3, broadly convex. Spiracle oblique, close behind and below level of eye ; slightly less than eye. Scales simple pointed denticles. Single median predorsal keel. First dorsal inserted over posterior portion of ventral base, length $1\frac{1}{3}$ in head ; second dorsal $1\frac{2}{5}$ to $1\frac{1}{2}$; anal $1\frac{1}{3}$ to $1\frac{2}{5}$; least depth of caudal peduncle 5 to $5\frac{1}{3}$; pectoral $1\frac{1}{3}$; ventral $1\frac{4}{5}$; caudal $3\frac{7}{8}$ to $4\frac{1}{8}$ in rest of body from subcaudal origin.

Back drab gray, below white. Iris dark gray. Fins all with more or less deeper drab terminally.

Two 138 to 188 mm.

SPHYRNIDÆ

Sphyrna blochii (Cuvier).

Depth $5\frac{3}{4}$; head $3\frac{1}{2}$, length $2\frac{5}{8}$ in its width. Snout tip to mouth slightly less than least width of oculonarial expansion and front edge or between nostrils broadly rounded. Eye small, 6 times to nostril. Mouth length $\frac{2}{3}$ its width, which $1\frac{1}{3}$ in space between mouth and front snout edge. Teeth not developed. Space between nostril and eye little less than internasal space; deep groove from nostril to eye and forward nearly half way to front end of snout. First dorsal inserted over pectoral base posteriorly, length little greater than head or $3\frac{1}{8}$ to caudal base; second dorsal inserted little behind anal origin, length 2 in head; anal $1\frac{7}{8}$; least depth of caudal peduncle $3\frac{2}{3}$; pectoral $1\frac{1}{5}$, width $1\frac{7}{8}$ its length; ventral length $2\frac{1}{5}$ in head; caudal 2 in rest of body, lower lobe $2\frac{3}{4}$ in upper.

Gray brown above, white below. Edges above of oculonarial expansion, anal, caudal and paired fins all narrowly paler. Iris slate.

One 347 mm.

PRISTIDÆ

Pristis cuspidatus, Latham.

Depth $11\frac{3}{4}$ to subcaudal origin; head $2\frac{3}{5}$, width at front of spiracles $4\frac{1}{3}$. Rostrum long, slender, tapers very gradually; rostral teeth 23–24, narrowly triangular, with inner subbasal barb, not extending on basal fourth of rostrum; eye $2\frac{7}{8}$ in interorbital; mouth width slightly greater than interorbital or $6\frac{1}{5}$ in head; teeth in about 62 rows; nostril oblique, larger than eye, $2\frac{3}{5}$ in interorbital; interorbital with superciliary regions little convex, higher than broad median convexity, width $6\frac{1}{2}$ in head. Skin smooth. First dorsal inserted behind ventral base, long as high or 4 in head; second dorsal little higher than long, $4\frac{1}{10}$ in head; subcaudal $1\frac{1}{2}$ in caudal which $2\frac{4}{5}$ in head; caudal peduncle depth $\frac{2}{3}$ its width which $2\frac{1}{5}$ in interorbital; pectoral long as wide, $3\frac{1}{5}$; ventral $3\frac{7}{8}$.

Dark drab or neutral gray above, below whitish. Borders of fins and lateral fold of tail whitish. Iris dark gray. Rostral teeth all pale.

One 615 mm.

TORPEDINIDÆ

Torpedo sinus-persici (Olfers).

Two examples 176 to 190 mm. In no way like the figure by Sauvage, as in my larger example the body is marked by more or less vermiculated dark or neutral brown, the lines variably as bars, spots, etc. Also very much more numerous and smaller or crowded along the front border of disk. In the smaller example the markings are more as large dark neutral dusky blotch or spots.

DASYATIIDÆ

Dasyatis uaranak (Forskål).

Two examples, disk length to hind ventral edge 240 to 243 mm., disk width 225 to 263 mm., tail 724 to 743 mm. longer. Smaller a male with small tubercles of back continued forward to postocular and interorbital space. Also dark and tail uniform brown, whereas in large example it is alternately banded dark brown and white, latter color of much narrower width. In both examples body uniform, though smaller soiled over entire lower surface.

Jaws of a large example, the dentary width 127 mm. These slightly undulated and with 45 or 46 rows of transversely keeled teeth in each.

I have also compared two from the Philippines and two from Sumatra.

The former with the disk and tail above brown, with numerous, close set, rounded, dark spots, but little smaller and more crowded about borders of disk. On tail spots as single series all along upper surface. Entire under surface

creamy white. The Sumatra specimens are from Padang, disk length 196 to 225 mm., tail 521 to 586 mm., width 215 to 243 mm. Brown above, darker in disk center and on disk posteriorly number of round whitish spots with darker brown borders than body color. Tail basally with similar spots and mostly entire length with many equal whitish rings. Below white, tinted pale brown along edges. Listed by me as *Dasyatis russelli* in 1904.

Dasyatis imbricatus (Schneider).

Disk nearly wide as long, little concave on front edges, broadly rounded at angles and behind. Snout produced, sharp angular point, length to eye slightly longer than length to mouth, or nearly double interorbital width ; eye $3\frac{3}{5}$ in interorbital ; mouth width 3 in space to snout tip, little undulate ; 2 lower papillæ in mouth ; teeth in 32 rows in each jaw ; interorbital $1\frac{7}{8}$ in snout, slightly depressed medianly. Spiracles large as eye. Interorbital and short space before eyes, cranium and middle of back broadly covered with minute rough plates or tubercles ; at center of disk small spine and slightly enlarged vertebral row to tail where about 9 down to caudal spines, posterior of which larger and $2\frac{1}{4}$ in snout. Tail without membranes. Claspers moderate.

Uniform brown above, under surface whitish.

One example, disk length to hind ventral ends 238 mm., tail 285 mm. longer, disk width 225 mm.

Dasyatis sephen (Forskål).

One example 175 mm. from snout tip to hind disk edge and tail 443 longer. Greatly like Day's figure except it has but one caudal spine. Two large bony tubercles in middle of disk around which whole of middle of back, base of tail and interorbital covered with armour or pavement of minute flattened tubercle like scales. Lower fold of tail broad. Disk brown above, whitish below. Iris and spiracles dark gray. Lower fold of tail neutral dusky. Under surface of disk whitish, margins posteriorly and tail below dusky brown.

Another, length 250 mm. to vent and tail 528 mm. longer, from the Philippines, shows the following :—

Disk partly quadrangular $1\frac{1}{8}$ its width ; head, measured to first gill-opening, $3\frac{1}{8}$ to vent ; snout blut, to eye $1\frac{1}{3}$ in head ; snout tip to mouth front $1\frac{3}{5}$; eye elevated, 4 in snout, 4 in interorbital ; mouth small, well undulated, width 2 in snout ; interorbital about equals snout, depressed. Front nasal valves united and with free edge behind isthmus before mouth. Spiracle large, deep, larger than eye. Median portion of back and head with broad area of finely rough shagreen denticles and in middle of disk several enlarged ; tail, outer portions of disk and all lower surface smooth. Tail with long broad fold below, its depth equals spiracle length. Body uniform brown above, below whitish and membrane below tail neutral black. Under surface of tail darker neutral gray medially.

Dasyatis zugei (Müller and Henle).

Disk subquadrangular, rounded on outer angles and posteriorly. Snout produced in rather slender elongated point, nearly 3 times interorbital ; eye $3\frac{1}{5}$ to $3\frac{3}{5}$ in interorbital ; mouth width $3\frac{3}{5}$ to $3\frac{3}{4}$ in space to snout tip, but slightly undulated ; no lower papillæ in mouth ; teeth 30 to 34 rows in each jaw ; interorbital $2\frac{3}{4}$ to $2\frac{5}{8}$ in snout, depressed, with broad fontanel. Skin smooth. Upper surface of tail with row of 5 median spine like tubercles and 2 caudal spines, posterior of which $2\frac{1}{10}$ in snout. Tail smooth, with slight membrane above and below.

Brown above, more or less dusky brown medianly, below whitish largely soiled with dusky or dirty brown. Membranes of tail neutral black.

Two 155 to 190 mm. in disk length, tail 150 to 293 mm. longer, disk width 155 to 190 mm. Readily known by its extended snout giving much the outline of various species of *Raja*.

Pteroplatea pœciloura (Shaw).

Length of disk $1\frac{9}{10}$ its width. Head greatly depressed. Snout about $1\frac{1}{6}$ in interorbital ; eye $5\frac{1}{2}$; mouth width $1\frac{1}{5}$; teeth in about 40 rows in each jaw ; internasal space $1\frac{1}{3}$ in width. Interorbital flat, with broad median depression,

greater than interspiracle width. Spiracle larger than eye, without tentacle. Skin smooth. No dorsal. No caudal spine. Tail without dorsal folds. Brown above. Iris gray. Tail whitish, with 9 broad blackish bands, much wider than pale interspaces. One 153 mm. in disk length, tail 90 mm. longer, width 285 mm.

MYLIOBATIDÆ

Ætomylæus milvus (Müller and Henle)

Disk length $1\frac{3}{5}$ its width, convex along front edges, concave along hind edges and outer angles rather narrow. Skull wide, broadly convex in front. Snout about twice long as nasal valves, rounded anteriorly. Eye rather small, $5\frac{1}{2}$ in interorbital. Mouth width $2\frac{1}{2}$ in interorbital. Median teeth 7 or 8 times wide as long and 3 series of small laterals each side. Nasal valves form broad free flap, leaving wide space before teeth, hind edge shortly fringed and with slightly median notch. Internasal space $1\frac{7}{8}$ in space between snout tip to mouth. Interorbital level, fontanel moderate. Spiracle little larger than eye. Body entirely smooth. Dorsal origin above ends of ventral bases, hind margin not free from tail, edge $1\frac{3}{5}$ in interorbital. Ventral little over interorbital, width little less than half its length; claspers extend but little beyond ventrals. No caudal spine.

Back dark uniform brown, without traces of spots. Below whitish, with disk marginally more or less soiled with dirty brown. Iris dark gray. Tail brown, paler below anteriorly.

One with disk length to clasper ends 280 mm., tail 328 mm. longer, disk width 438 mm.

CHIROCENTRIDÆ

Chirocentrus dorab (Forskål).

One example 500 mm.

CLUPEIDÆ

Ilisha elongata (Bennett).

Depth 3; head $3\frac{3}{4}$, width $2\frac{1}{3}$. Snout $3\frac{3}{4}$ in head from snout tip; eye 3, greater than snout, nearly three times interorbital, front adipose lid covering first third of iris; maxillary reaches $\frac{3}{5}$ in eye, expansion $1\frac{2}{3}$ in eye, length $1\frac{4}{5}$ in head; teeth villiform, in narrow bands in jaws and on each palatine, broad band on tongue, none on vomer; mandible protrudes about $\frac{3}{5}$ eye-diameter before snout; interorbital $6\frac{3}{4}$ in head, little convex. Gill-rakers 8 + 20, lanceolate, little longer than gill-filaments or 2 in eye.

Scales all fallen, 44 + 4 in median lateral series, about 17 transversely, 17 predorsal. Abdominal scutes 23 + 11. Dorsal III, 9, I (damaged), inserted midway between snout tip and caudal base; anal III, 35 (damaged), begins below last dorsal rays, length 3 in combined head and body; caudal slightly shorter than total head length, well forked; least depth of caudal peduncle $3\frac{1}{5}$ in head.

Drab gray, evidently largely silvery white. Iris grayish. Fins pale.

One example 305 mm.

DOROSOMIDÆ

Clupanodon thrissa (Linné).

Depth $2\frac{3}{4}$ to $2\frac{7}{8}$; head $3\frac{1}{8}$ to $3\frac{3}{5}$, width $2\frac{1}{5}$ to $2\frac{1}{2}$. Snout $4\frac{1}{8}$ to $4\frac{1}{3}$ in head; eye $3\frac{2}{5}$ to $3\frac{1}{2}$, greater than snout or interorbital; adipose lids broad, cover $\frac{1}{3}$ of iris anteriorly and posteriorly; maxillary reaches little beyond front of eye, length $3\frac{4}{5}$ to $4\frac{1}{2}$, convexly elevated. Gill-rakers 132 + 160 ? very fine, setiform, slightly longer than gill-filaments or $2\frac{1}{5}$ in eye.

Scales 44 or 45 + 3 or 4 in median lateral series, 17 transversely, 16 predorsal; postocular, occipital and suprascapular regions, cheek and preopercle venulose; 2 or 3 pronounced vertical lines, sometimes complete and many finer parallel vertical striæ; broadly entire apically. Abdominal serræ 17 to 19 + 12. Dorsal III, 12, I or III, 13, I, last ray $1\frac{1}{10}$ to $1\frac{1}{5}$ in head; anal III, 19, I,

first branched ray $3\frac{2}{5}$ to $3\frac{2}{3}$; least depth of caudal peduncle $2\frac{1}{4}$ to $2\frac{2}{5}$; pectoral $1\frac{1}{3}$ to $1\frac{1}{2}$; ventral $2\frac{1}{5}$ to $2\frac{2}{5}$; caudal forked, $3\frac{1}{8}$ to $3\frac{1}{4}$ in combined head and body to caudal base.

Back brown, each scale with slightly darker center, made up of dusky brown spots or dots. Dusky black blotch about 3 or 4 scales behind suprascapula, deep as vertical eye diameter though width less than eye width. From above upper part of dark blotch obsolete dull brown band extends back towards middle of caudal base. All below pale or whitish. Iris gray. Fins pale brownish. Dorsal and caudal dusted with dusky, especially about margins.

Three examples 85 to 104 mm.

ENGRAULIDIDÆ

Engraulis hamiltonii, Gray.

Depth $3\frac{3}{5}$; head 4 to $4\frac{1}{5}$, width $2\frac{1}{5}$. Suout $4\frac{7}{8}$ to 5 in head ; eye $3\frac{7}{8}$ to 4 entirely covered by adipose eye-lids, greater than snout or $1\frac{1}{8}$ in interorbital ; maxillary extends little beyond gill-opening or nearly to pectoral origin, expansion $1\frac{1}{2}$ in eye ; teeth small, uniserial in jaws, smaller and in narrow band on each palatine, none on vomer ; interorbital $3\frac{2}{3}$ to $3\frac{4}{5}$, convexly elevated with slight median ridge. Gill-rakers 9 + 12, lanceolate, $1\frac{1}{3}$ in eye.

Scales 43 + 3 in median lateral series, 12 transversely, 22 predorsal ; opercles, cheeks, occipital and scapulary regions venulose, area at suprascapula especially broad ; 5 or 6 transverse radiating striæ and apical margin broadly reticulated. Abdominal serræ 16 or 17 + 10. Dorsal III, 11, I, third simple ray $1\frac{1}{5}$ to $1\frac{1}{4}$ in head ; anal III, 38, I, third simple ray $1\frac{3}{4}$ to $1\frac{4}{5}$; least depth of caudal peduncle $2\frac{1}{5}$ to $2\frac{1}{2}$; pectoral $1\frac{1}{10}$ to $1\frac{1}{8}$; ventral $2\frac{4}{5}$ to 3.

Back brown, sides paler and below whitish. Iris slate. Dark brown on suprascapula. Fins all pale, dorsal and caudal dark gray marginally.

Three 165 to 175 mm. 1 have also compared 2 larger examples 178 to 225 mm. from the Philippines, wrongly listed by me in 1918 as *Thrissocles mystax*. They show :—

Depth $3\frac{1}{3}$ to $3\frac{2}{5}$; head $4\frac{1}{4}$ to $4\frac{1}{2}$; width $2\frac{1}{3}$ to $2\frac{1}{2}$. Snout $4\frac{1}{8}$ to $5\frac{1}{5}$ in head ; eye $3\frac{1}{2}$ to $4\frac{2}{5}$, $1\frac{1}{8}$ to $1\frac{1}{5}$ in interorbital ; maxillary expansion 2 to 3 in eye ; jaws even, snout not projecting ; interorbital $3\frac{4}{5}$ to 4 in head. Gill-rakers 11 + 14, equal eye.

Scales 44 or 45 + in median lateral series, deciduous, 12 or 13 transversely, 18 to 20 predorsal ; 4 to 6 transverse parallel vertical striæ, variously incomplete medianly and with age 4 to 6 parallel close vertical apical striæ, circuli minute and vertical. Abdominal serræ 17 or 18 + 10. Dorsal III, 11, third simple ray $1\frac{1}{6}$ to $1\frac{1}{3}$ in head ; anal III, 35, I, first branched ray $1\frac{4}{5}$ to $1\frac{7}{8}$; least depth of caudal peduncle $2\frac{1}{4}$ to $2\frac{1}{3}$; pectoral $1\frac{1}{5}$ to $1\frac{1}{4}$; ventral 3 to $3\frac{1}{4}$; caudal $3\frac{4}{5}$ to 4 in head and body to caudal base, well forked, lobes sharply pointed.

Pale brown, sides and below lighter. Iris gray. Fins all pale.

MURÆNESOCIDÆ

Murænesox cinereus (Forskål).

One 618 mm.

TACHYSURIDÆ

Netuma thalassinus, Rüppell.

One 285 mm. I have 17 from the Phillipines and 1 from Padang, Sumatra, the latter 616 mm., for comparison.

Tachysurus venosus (Valenciennes).

Depth $3\frac{4}{5}$; head $3\frac{1}{5}$, width $1\frac{1}{3}$. Snout $2\frac{1}{2}$ in head ; eye 8, $3\frac{1}{5}$ in snout, $4\frac{1}{5}$ in interorbital; mouth width $2\frac{2}{5}$ in head, lower jaw inferior; maxillary barbel reaches $\frac{1}{4}$ in depressed pectoral, outer mental reaches to pectoral origin, inner little shorter ; teeth in jaws villiform, in moderately wide bands and triangular palatine area on each side much deeper than wide ; interorbital $1\frac{3}{4}$ in head ; frontal fontanel rather narrow, with very narrow groove to predorsal plate. Gill-rakers 5 + 9, lanceolate, $1\frac{3}{4}$ in gill-filaments, which slightly less than eye.

Parietal bones, predorsal and humeral plates rugosely striate or granular, skin otherwise smooth.

Dorsal I, 7, front edge of spine with row of low granular like serræ and 14 very small antrorse ones along median hind edge, first ray $1\frac{1}{3}$ in head; adipose fin $2\frac{7}{8}$; anal VII, 14, I, first branched ray $2\frac{2}{5}$; caudal $1\frac{1}{3}$, well forked; least depth of caudal peduncle $3\frac{7}{8}$; pectoral $1\frac{3}{5}$, spine with fine serræ along front edge and about 14 antrorse serrae along hind edge; ventral $1\frac{4}{5}$.

Back and upper surface drab brown, soiled whitish below. Iris grayish. Barbels gray. Paired fins and anal whitish, terminally with grayish.

One 313 mm.

SILURIDÆ

Mystus vittatus (Bloch).

Depth $4\frac{2}{5}$ to $4\frac{3}{5}$; head $3\frac{2}{5}$ to $3\frac{3}{4}$, width $1\frac{2}{5}$. Snout 3 to $3\frac{1}{10}$ in head; eye 5 to $5\frac{1}{2}$, $1\frac{2}{3}$ to 2 in snout, $1\frac{4}{5}$ to 2 in interorbital; mouth width $2\frac{2}{5}$ to $2\frac{2}{3}$ in head; nasal barbel reaches back little beyond eye or $2\frac{1}{3}$ in head; maxillary barbel reaches ventral origin; outer mental barbel reaches $\frac{3}{5}$ in depressed pectoral fin; inner mental barbel shorter or $1\frac{3}{4}$ in head; teeth villiform, in bands in jaws and across vomer and palatines; interorbital $2\frac{4}{5}$ to 3 in head, about level; opercle with fine radiating striæ; frontal fontanel broad, nearly reaches occipital plate; occipital process reaches as short point $\frac{1}{3}$ to dorsal plate. Gill-rakers 9 + 28, finely lanceolate, little larger than gill-filaments or slightly less than eye.

Skin smooth. Cranium and humeral region rugose striate, latter less so.

Dorsal I, 7, I, ossified portion of spine $1\frac{3}{4}$ to $1\frac{7}{8}$ in head, with 7 or 8 antrorse serræ along hind edge; adipose fin about $\frac{3}{4}$ of anal; Anal IV, 9, I or IV, 10, I, first branched ray $2\frac{1}{5}$ to $2\frac{2}{5}$; caudal about equals head, strongly forked, lower lobe usually little shorter; least depth of caudal peduncle $2\frac{1}{3}$ to $2\frac{2}{5}$; pectoral $1\frac{1}{3}$ to $1\frac{2}{5}$, with 8 to 11 antrorse serræ on inner edge of spine; ventral 2 to $2\frac{1}{8}$.

Neutral olive above, becoming lived or drab gray to whitish below. Maxillary and nasal barbels dark, others pale. Iris gray. Fins all gray brown.

Four examples 77 to 108 mm. All show the ventrals inserted distinctly or entirely behind the first dorsal base. They all show only obsolete traces of pale longitudinal bands, in fact greatly resembling Day's figure 3 of his plate 98.

Jordan has named *Macrones* (non Newman 1841) Dumeril 1856, orthotype *Bagrus lamarii* Valenciennes, as *Aoria* (Genera of Fishes, pt. 2, 1919, p. 269). *Aoria* is hardly available as both the older names of *Hemibagrus* Bleeker and *Aspidobagrus* Bleeker, also fall as synonyms. *Mystus* Gronow is proposed in the Zoophylaceum, 1763, p. 124, type *Bagrus halepensis* Valenciennes, and later introduced by Scopoli, Introd. Hist. Nat., 1777, p. 451, type *Bagrus halepensis* Valenciennes, virtually.

SYNODONTIDÆ

Saurida tumbil (Bloch).

Four 140 to 325 mm. Brown above, each scale on back edged with darker. Whitish below. Branchiostegals with grayish. Iris gray. Fins brown. Dorsal, caudal and paired fins neutral gray terminally. Also compared with two from Padang, Sumatra, 127 to 344 mm.

Harpodon nehereus (Buchanan-Hamilton).

Two 200 to 220 mm.

HEMIRAMPHIDÆ

Hemiramphus unifasciatus, Ranzani.

Two 137 to 143 mm. Compared with an example 133 mm. from Padang, Sumatra, 1 listed as *Hemiramphus neglectus*.

SPHYRÆNIDÆ

Sphyræna jello, Cuvier.

Depth $8\frac{1}{5}$; head $3\frac{1}{5}$, width $3\frac{3}{5}$. Snout $2\frac{1}{8}$ in head from snout tip; eye 6, $2\frac{4}{5}$ in snout, $1\frac{1}{5}$ in interorbital; maxillary not quite reaching opposite eye,

expansion 2, length $2\frac{1}{3}$ inhead; interorbital $5\frac{1}{3}$, level or with only slight median depression; preopercle rounded convexly. No gill-rakers.

Scales 125 + 8, 15 above, 13 below, 38 predorsal to occiput.

Dorsal V-I, I, 8, I, first spine $2\frac{3}{4}$ in total head length, first branched ray $2\frac{2}{5}$; anal II, I, 7, I, first branched ray $2\frac{3}{4}$; caudal $1\frac{1}{2}$, forked; least depth of caudal peduncle $4\frac{3}{4}$; pectoral $2\frac{3}{4}$; ventral $3\frac{1}{2}$.

Back brown, below pale to whitish. Over back 12 dark transverse bands, wider than interspaces and extend down to middle of sides. Iris gray. Dorsals and caudal brownish, other fins paler.

One 258 mm. Also four from the Philippines for comparison, 106 to 257 mm. They show:

Depth $7\frac{1}{2}$ to $7\frac{4}{5}$; head 3 to $3\frac{1}{6}$, width $4\frac{1}{8}$ to $4\frac{1}{4}$. Snout $2\frac{1}{5}$ to $2\frac{1}{4}$ in head from snout tip; eye $5\frac{1}{8}$ to $6\frac{1}{4}$, $2\frac{7}{8}$ to 3 in snout, 1 to $1\frac{1}{3}$ in interorbital; maxillary $2\frac{1}{3}$ to $2\frac{2}{5}$ in head, expansion $1\frac{7}{8}$ to 2 in eye; interorbital 6 to $6\frac{1}{2}$ in head, level; preopercle edge convex.

Scales 110 to 120 + 10 to 12 in lateral line, 13 above, 13 below, 32 to 40 predorsal. Dorsal V-I, 8, I, first spine $2\frac{4}{5}$ to $3\frac{2}{3}$ in total head length, first ray $2\frac{3}{5}$ to $2\frac{3}{4}$; anal II, I, 7, I, second spine $5\frac{1}{5}$ to $6\frac{1}{2}$, first ray $2\frac{7}{8}$ to 3; caudal $1\frac{1}{2}$ to $1\frac{3}{4}$, well forked; pectoral $2\frac{2}{3}$ to $2\frac{4}{5}$; ventral $3\frac{3}{5}$ to $3\frac{2}{3}$.

Neutral brown above, sides and below pale to whitish. About 12 deep neutral gray spots along side and not larger than eye. Dorsals and caudal grayish other fins whitish.

Sphyræna obtusata, Cuvier.

Depth $5\frac{3}{4}$; head $2\frac{3}{4}$, width $2\frac{1}{3}$. Snout $2\frac{1}{3}$ in head from snout tip; eye $4\frac{3}{4}$, 2 in snout, subequal with interorbital; maxillary not quite reaching to eye, expansion $1\frac{4}{5}$ in eye, length $2\frac{2}{5}$ in head; interorbital 5, level, eyes slightly protrude above each side; preopercle nearly forms right angle. Gill-rakers 0 + 2.

Scales 83 + 5, 9 above, 10 below, 18 predorsal to occiput. Dorsal V-I, I, 8, I, first spine $2\frac{7}{8}$ in total head length, first branched ray 3; anal II, I, 8, I, first branched ray $3\frac{1}{10}$; caudal $1\frac{1}{3}$, deeply forked; least depth of caudal peduncle $4\frac{1}{8}$; pectoral $2\frac{1}{2}$, reaches beyond spinous dorsal origin; ventral $2\frac{2}{3}$, inserted before spinous dorsal origin.

Back brown, below whitish. Iris deep gray. Dorsals and caudal brownish, other fins pale.

One 272 mm. Also 4 from the Philippines, 162 to 185 mm. They show:—

Depth $5\frac{3}{4}$ to $7\frac{1}{8}$; head $2\frac{4}{5}$ to $2\frac{7}{8}$, width $3\frac{1}{10}$ to $3\frac{2}{3}$. Snout $2\frac{1}{6}$ to $2\frac{1}{4}$ in head from snout tip; eye 5 to $5\frac{1}{5}$, $2\frac{1}{5}$ to $2\frac{1}{3}$ in snout, greater than interorbital; maxillary reaches $\frac{4}{5}$ to $\frac{7}{8}$ to eye, expansion $2\frac{2}{5}$ to $2\frac{3}{4}$ in eye, length $2\frac{2}{5}$ to $2\frac{3}{5}$ in head; teeth mostly vertically erect, 2 pairs of upper front canines, single lower symphyseal canine and several smaller laterals which larger than others in mandible; each palatine with row of fine teeth preceded by a row of 3 to 5 large canines; interorbital $6\frac{1}{3}$ to $7\frac{1}{2}$, very slightly convex and largely depressed medianly; preopercle edge rectangular, flap-like. Gill-rakers 0 + 2, half of gill-filaments or 4 in eye.

Scales 75 to 78 + 9 or 10, 8 above, 10 below, 27 predorsal to hind eye edge; 6 or 7 rows of cheek scales; 32 to 36 basal radiating striæ and complete circuli with about 30 apical. Dorsal V-I, 9, I, first spine $2\frac{2}{5}$ to $3\frac{1}{5}$ in total head length, first ray $2\frac{7}{8}$ to $3\frac{7}{8}$; anal I or II, 8, I or 9, I, last spine $5\frac{1}{2}$ to 7, first ray 3 to 4; caudal $1\frac{3}{5}$ to $1\frac{2}{3}$, forked; pectoral $2\frac{1}{2}$ to $3\frac{1}{4}$, reaches to or little beyond spinous dorsal origin; ventral $2\frac{3}{4}$ to $3\frac{1}{4}$, inserted well before spinous dorsal.

Back and above brown, below silvery white. Pale, diffuse longitudinal gray streak along middle of side close below lateral line. Iris silvery white, with grayish. Dorsals and caudal dusky, with pale yellowish tinge basally, other fins pale yellowish white.

ATHERINIDÆ

Atherina valenciennesi, Bleeker.

Depth $4\frac{3}{4}$ to 5; head 4 to $4\frac{1}{8}$, width $1\frac{3}{4}$ to $1\frac{4}{5}$. Snout $3\frac{1}{2}$ to 4 in head; eye $2\frac{2}{3}$ to $2\frac{3}{4}$, greater than snout or 1 to $1\frac{1}{8}$ in interorbital; maxillary $2\frac{3}{5}$ to $2\frac{4}{5}$ in head, reaches eye; teeth villiform, minute, in bands in jaws, on vomer and

palatines ; interorbital $2\frac{3}{5}$ to $2\frac{1}{2}$, level. Gill-rakers 6 + 19, lanceolate, little longer than gill-filaments or $2\frac{1}{5}$ in eye.

Scales 39 or 40 + 4 or 5, 8 transversely, 19 to 21 predorsal, single row on cheek ; 2 or 3 close set median basal points, 25 to 35 parallel vertical striæ. Dorsal V–I, 9, I, first spine $2\frac{1}{5}$ to $2\frac{1}{4}$ in head, first branched ray $1\frac{2}{3}$ to $1\frac{4}{5}$; anal III, I, 10, I, first branched ray $1\frac{2}{3}$ to $1\frac{3}{4}$; caudal $1\frac{1}{8}$ to $1\frac{1}{10}$, forked ; least depth of caudal peduncle 3 to $3\frac{1}{8}$; pectoral $1\frac{1}{6}$ to $1\frac{1}{4}$; ventral $1\frac{4}{5}$ to $1\frac{7}{8}$. Vent before first third in depressed ventral and 6 scales between it and vertical line through body to first dorsal origin.

Light brown generally, paler below. Each scale on back above sprinkled with dusky brown dots, though leaving broad uniform margin. Underlaid gray band from pectoral axil to caudal base medianly, widest at latter and this not quite equal to eye. Iris slaty. Row of dusky dots on lower surface of tail close along anal base. Fins all pale, hind caudal edge dusky. Narrow dusky line across pectoral base.

Three 70 to 76 mm.

MUGILIDÆ

Mugil dussumieri, Valenciennes.

Depth 4 ; head $3\frac{1}{4}$ to $3\frac{2}{3}$, width $1\frac{3}{5}$ to $1\frac{3}{4}$. Snout $3\frac{1}{5}$ to $3\frac{1}{4}$ in head ; eye $3\frac{3}{5}$ to 4, greater than snout, $1\frac{1}{7}$ to $1\frac{2}{3}$ in interorbital, broad adipose lids cover $\frac{1}{4}$ of iris in front and behind ; mouth width $3\frac{1}{10}$ to $3\frac{1}{5}$ in head ; upper lip rather broad, width $\frac{1}{3}$ of eye ; maxillary well exposed when mouth closes ; interorbital $2\frac{1}{4}$ to $2\frac{1}{2}$ in head, nearly level ; lower preorbital edge finely serrated. Gill-rakers 27 + 45, finely lanceolate, $1\frac{1}{4}$ in gill-filaments.

Scales 30 + , 11 transversely, 23 predorsal ; soft vertical fins finely scaled ; no axillary pectoral scale ; scales with 6 to 9 basal radiating striæ, 74 to 86 weak apical denticles with 8 to 10 transverse series of basal elements and circuli fine. Dorsal IV–I, 8, I, first spine $1\frac{3}{4}$ to $1\frac{4}{5}$ in head, first branched ray $1\frac{1}{2}$ to $1\frac{4}{5}$, soft dorsal origin over middle of anal base ; anal III, 9, I, first branched ray $1\frac{4}{5}$; caudal 1 to $1\frac{1}{10}$, deeply emarginate ; least depth of caudal peduncle $2\frac{1}{5}$ to $2\frac{1}{3}$; pectoral $1\frac{1}{2}$ to $1\frac{3}{5}$; ventral $1\frac{1}{2}$.

Back olive brown, below whitish. Iris slate gray. Fins brownish, lower whitish and no dark spot at pectoral origin.

Two 100 to 110 mm.

Mugil ophuysenii, Bleeker.

Depth $3\frac{4}{5}$ to 4 ; head $3\frac{4}{5}$ to 4, width $1\frac{1}{2}$ to $1\frac{3}{5}$. Snout $3\frac{7}{8}$ to 4 in head ; eye $3\frac{4}{5}$ to 4, equals snout, $1\frac{7}{8}$ to 2 in interorbital, broad adipose lids cover iris $\frac{1}{3}$ in front and behind ; mouth width 3 in head, as seen below would form an obtuse angle ; upper lips rather broad, width $3\frac{1}{5}$ in eye ; interorbital 2 to $2\frac{1}{5}$, broadly convex ; maxillary slightly visible when mouth closes ; lower preorbital edge minutely serrated. Gill-rakers 31 + 43, finely lanceolate, $1\frac{3}{5}$ in gill-filaments or $1\frac{3}{4}$ in eye.

Scales 32 to 34 + 3, 12 transversely, 17 or 18 predorsal ; axillary pectoral scale $2\frac{4}{5}$ in fin ; median ventral scaly flap $\frac{2}{3}$ of fin ; soft dorsal, caudal and anal densely covered with fine scales ; scales with 6 basal radiating striae, apical borders finely fringed and circuli minute. Dorsal IV–I, I, 7, I, first spine $1\frac{4}{5}$ in head, first branched ray $1\frac{4}{5}$, origin of second dorsal over first third of anal base; anal III, I, 8, I, first branched ray $1\frac{3}{5}$ to $1\frac{2}{3}$; caudal $3\frac{2}{5}$ to $3\frac{1}{2}$ to caudal base, large, emarginate behind ; pectoral $3\frac{4}{5}$ to $4\frac{1}{8}$, reaches slightly beyond first dorsal origin ; ventral $1\frac{1}{2}$ to $1\frac{3}{5}$ in head ; least depth of caudal peduncle 2.

Back olive brown, sides and below whitish. Fins all pale brown, edges of dorsal and caudal dusky, other fins paler. Pectoral with small neutral dusky spot at origin of fin. Iris gray.

Two 158 to 160 mm. I have not previously met with this East Indian species and it does not appear to have been recorded from Bombay. My specimens agree with Weber and Beaufort's description. This species differ from *Mugil seheli* in the presence of the broad adipose eyelids and the origin of the first dorsal nearer the snout tip than the caudal base.

Mugil vaigiensis, Quoy and Gaimard.

Three examples, 42 to 45 mm. All show the dorsals and anal apically and pectoral superiorly, neutral dusky to blackish.

Mugil borneensis, Bleeker.

Depth $3\frac{1}{5}$ to $3\frac{3}{5}$; head $3\frac{1}{3}$ to $3\frac{1}{4}$, width $1\frac{3}{5}$ to $1\frac{3}{4}$. Snout $3\frac{3}{4}$ to $3\frac{7}{8}$; eye $3\frac{1}{4}$ to $3\frac{7}{8}$, much greater than snout, $1\frac{2}{5}$ to $1\frac{4}{5}$ in interorbital, adipose lid barely covering $\frac{1}{4}$ of iris; mouth width $3\frac{1}{10}$ to $3\frac{1}{3}$ in head; upper lip moderately wide, width $3\frac{3}{5}$ in eye; maxillary well exposed when mouth closes; lower preorbital edge serrate; interorbital $2\frac{3}{5}$ to $2\frac{1}{2}$, broadly convex. Gill-rakers 24 + 36, finely lanceolate, $1\frac{3}{5}$ in gill-filaments which $1\frac{1}{5}$ in eye.

Scales 30 to 32 + in median lateral series, 11 or 12 transversely, 20 to 21 predorsal; soft vertical fins with small scales basally; scales with 5 or 6 basal radiating striæ, 41 weak apical denticles, with 3 or 4 transverse series of basal elements and circuli fine. Dorsal IV–I, 8, I, first spine $1\frac{3}{5}$ to $1\frac{7}{8}$ in head, first branched ray $1\frac{4}{5}$ to $1\frac{7}{8}$, soft dorsal origin opposite last fourth of anal base or totally behind same; anal III, 9, I, first branched ray $1\frac{4}{5}$ to 2; caudal $1\frac{1}{6}$ to $1\frac{1}{4}$, concave behind; least depth of caudal peduncle $2\frac{2}{5}$ to $2\frac{1}{2}$; pectoral $1\frac{1}{2}$ to $1\frac{2}{3}$, without axillary scale; ventral $1\frac{2}{3}$ to $1\frac{4}{5}$.

Back brown, side and below paler to whitish. Iris slate gray. Dorsal, caudal and pectoral brownish, other fins whitish, without markings and no dark spot at pectoral origin.

Three 58 to 67 mm.

POLYNEMIDÆ

Polydactylus sextarius (Bloch).

One example, 206 mm. It has 7 pectoral filaments each side. Pectoral fin pale and blackish blotch after third scale of lateral line extending over 4 scales.

Polydactylus plebejus (Broussont).

Two, 280 to 342 mm. Larger with each caudal lobe ending in filament. Also it has dorsals, anal, pectoral and ventral blackish while in the smaller one the ventrals and anal are only dark brown.

SCOMBRIDÆ

Rastrelliger brachysomus (Bleeker).

Depth $3\frac{3}{8}$; head $3\frac{1}{8}$, width $2\frac{1}{5}$. Snout $3\frac{3}{8}$ in head from snout tip; eye 5, $1\frac{1}{4}$ in snout, $1\frac{1}{2}$ in interorbital, less than median third freed by broad adipose eyelids; maxillary reaches opposite hind eye edge, expansion $2\frac{1}{8}$ in eye, broadly sheathed by long preorbital, length 2 in head; narrow band of minute villiform teeth in each jaw, none on palate or tongue; interorbital $3\frac{1}{8}$, but little elevated and with snout above broadly flattened medially; preopercle with radiating venules, also each side of head above from behind eye and others along each side of predorsal squamation to suprascapula region. Gill-rakers 21 + 43, compressed, inner edges fringed with fine short setæ, longer than gill-filaments or $2\frac{7}{8}$ in total head length.

Scales 123 + in lateral line, 12 above, 27 below, 25 predorsal, not forming corselet, but little enlarged below pectoral base and on cheek; soft dorsal and anal densely covered with small scales. Large scales with marginal apical fringe of 32 points; vertical parallel striæ on scales 13 to 25 and on large scales about 35 on apical half. Dorsal X–I, I, 10, I — 5, first spine $1\frac{7}{8}$ in total head length, first branched ray 3; anal I, I, 10, I — 5, first branched ray 3; caudal $1\frac{1}{2}$, deeply forked; least depth of caudal peduncle 8; pectoral $2\frac{1}{5}$; ventral $2\frac{1}{2}$.

Back dull olive, sides and below whitish. Iris showing grayish with brassy through adipose lids. Fins all dull brownish, spinous dorsal more grayish and darker marginally, lobe of soft dorsal apically and hind caudal margin also with dusky. Lower fins more whitish.

One, 230 mm. This species is well figured by Jordan and Dickerson[1] from a specimen obtained at Fiji. Day knew it from the Andamans so that my example now shows it ranges from Bombay to Polynesia. I have also examined material from Melanesia.

Scomberomorus guttatus (Schneider).

Depth $4\frac{3}{4}$ head $4\frac{3}{4}$; width $2\frac{1}{8}$. Snout $3\frac{1}{10}$ in head; eye $6\frac{1}{2}$, $2\frac{1}{4}$ in snout, $2\frac{1}{5}$ in interorbital; maxillary extends well beyond eye, expansion $1\frac{3}{8}$ in eye, length

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[1] *Proc. U.S Nat. Mus.* 34, 1908, p. 609, fig. 3.

$1\frac{9}{10}$ in head; row of 36 compressed lanceolate teeth above, 26 below in jaws; areas of villiform teeth on vomer, palatines and tongue; interorbital $3\frac{1}{3}$ in head, convexly elevated. Gill-rakers 3 + 7, lanceolate, $\frac{1}{2}$ of gill-filaments which equal eye.

Scales minute, little evident; dorsal, anal and caudal lobes finely scaled; lateral line curves rather evenly along back, drops medianly to caudal peduncle. Dorsal XVI—IV, 15 + 9, third spine $2\frac{2}{3}$ in head, first branched dorsal ray $1\frac{4}{5}$ in head; anal III, 17 + 8, first branched ray $1\frac{7}{8}$; caudal 1, deeply forked lunately; least depth of caudal peduncle $4\frac{2}{3}$; pectoral $1\frac{3}{4}$; ventral $3\frac{1}{4}$.

Back neutral brown, shading more drab on sides and below whitish. On back many obscure neutral dusky to blackish spots, in about 6 longitudinal rows. Iris gray brown. Spinous dorsal neutral black, soft dorsal, pectoral and caudal brownish, other fins whitish.

One 450 mm.

TRICHIURIDÆ

Trichiurus savala, Cuvier.

One 465 mm. Eye 3 snout.

STROMATEIDÆ

Pampus cinereus (Bloch).

Depth $1\frac{1}{2}$; head $3\frac{2}{5}$, width $1\frac{4}{5}$. Snout $3\frac{4}{5}$ in head; eye $3\frac{1}{3}$, equals snout, $1\frac{2}{5}$ in interorbital; maxillary reaches opposite eye center, expansion $2\frac{4}{5}$ in eye, length from snout tip 2 in head; interorbital 2, convexly elevated; opercle with radiating striæ. Gill-rakers 2 + 8 short rudimentary points.

Dorsal IX, VI, 38, I, lobe of soft fin 3 in combined head and body; anal VI, IV, 35, I, lobe $2\frac{1}{2}$; lower caudal lobe $2\frac{1}{2}$, longer than upper; pectoral $2\frac{1}{4}$.

Brown, paler to whitish below with silvery reflections. Head and fins all more or less with dusky, except caudal which quite pale. Iris gray.

One 157 mm. The nominal *Pampus lighti* Evermann and Shaw[1] is likely a variant only 77 mm. long. It simply shows a slight increase in fin formulæ, as 'D. X, 48; A. VII, 45.' The alleged 'longer pectoral, more deeply forked caudal, whose lobes are unequal in length, shorter lower jaw, and the more pointed anterior portions of dorsal and anal' are surely valueless distinctions.

NOMEIDÆ

Psenes indicus, Day.

Depth $2\frac{1}{4}$ to $2\frac{1}{3}$; head 3 to $3\frac{1}{5}$, width 2. Snout $3\frac{3}{4}$ to $3\frac{4}{5}$ in head from snout tip; eye $3\frac{3}{4}$ to $3\frac{7}{8}$, subequal with snout, $1\frac{1}{3}$ to $1\frac{2}{5}$ in interorbital; maxillary not quite reaching eye, largely sheathed by rather narrow preorbital, expansion 3 to $3\frac{2}{3}$ in eye, length $3\frac{3}{5}$ to $3\frac{2}{3}$ in head; teeth minute, uniserial, even and firm in jaws, none on palate or tongue; interorbital $2\frac{3}{5}$ to 3, greatly elevated convexly. Gill-rakers 9 + 14, lanceolate, $2\frac{1}{3}$ in gill-filaments or $\frac{1}{3}$ of eye.

Scales very deciduous, all fallen, about 42 (pockets) in lateral line; narrowly imbricated on sides of body. Dorsal XI, I, 15, I, spines and rays very fragile, first ray $2\frac{3}{4}$ to $2\frac{4}{5}$ in total head length; anal III, 14, I, first branched ray $2\frac{3}{4}$ to $2\frac{4}{5}$; caudal 1 to $1\frac{1}{10}$, deeply forked; least depth of caudal peduncle $4\frac{1}{2}$ to $4\frac{4}{5}$; pectoral 1; ventral $2\frac{1}{5}$ to $2\frac{1}{3}$.

Largely deep drab gray, little paler below. Fins and head largely brownish. Iris deep gray.

Three 160 to 182 mm.

CARANGIDÆ

Scomberoides toloo (Cuvier).

Two 130 to 140 mm. This species is known by the maxillary reaching to or slightly beyond the hind edge of the eye, the rather large or broadly exposed

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[1] *Proc. California Acad. Sci.*, vol. 16, no. 4, 4th series, January 31, 1927, p. 114, Nanking.

scales and the pale soft dorsal, anal and caudal lobes, these not black. My examples show very faint traces of the 5 or 6 upper lateral neutral gray blotches and they are more as shown in Day's figure of *Chorinemus toloo*. The very incomplete account of *Chorinemus toloo* Cuvier[1] is based on an example 200 mm. long obtained at Malabar in which the spots are described as obliterated. It is, however, identified with the *Toloo-parah* of Russell,[2] who says 'the dorsal, anal and caudal fins are darkish' and gives the length as 400 mm. His figure shows the depth as $2\frac{4}{5}$, the maxillary reaching opposite hind eye edge and only the edges of the dorsal and anal, and hind caudal edge slightly shaded. The lateral line does not show the sharp angle below the front of the spinous dorsal as in my specimens and the 6 dark upper lateral spots are shown all above it. According to Klunzinger his *Chorinemus moadetta* = *Scomberoides toloo-parah* (Rüppell), differs in a more slender body and the soft dorsal and anal lobes blackish. This appears to be the species mostly met with in Oceania.

For comparison I have examined a series of 7 examples from the Philippines and 3 from Padang, Sumatra, 117 to 331 mm. These show :—

Depth $3\frac{1}{8}$ to $3\frac{1}{3}$; head 4 to $4\frac{1}{2}$, width $2\frac{1}{3}$ to $2\frac{2}{5}$. Snout $3\frac{2}{5}$ to 4 in head from snout tip ; eye $4\frac{1}{10}$ to $4\frac{1}{2}$, 1 to $1\frac{1}{2}$ in snout, $1\frac{1}{8}$ to $1\frac{1}{5}$ in interorbital ; maxillary reaches opposite hind eye edge, little beyond eye with age, expansion 2 to $3\frac{1}{8}$ in eye, length $1\frac{3}{5}$ to $1\frac{2}{3}$ in head ; outer row of lower teeth curved upward and outward ; interorbital $3\frac{1}{3}$ to $3\frac{1}{2}$, convex, elevated. Gill-rakers 3 + 13 lanceolate.

Scales close set, broadly lanceolate. Lateral line forms obtuse angle opposite front of spinous dorsal. Dorsal I, VII, I, 20, I, spines flattened, overlap, fifth $3\frac{1}{2}$ in total head length, second branched ray $1\frac{2}{5}$ to $1\frac{7}{8}$; anal II—I, 18, I, first ray $1\frac{2}{5}$ to 2 ; least depth of caudal peduncle 4 to $4\frac{4}{5}$; pectoral $1\frac{3}{5}$ to $1\frac{4}{5}$; ventral $1\frac{4}{5}$ to $1\frac{7}{8}$; caudal $1\frac{1}{4}$, $4\frac{1}{5}$ in combined head and body to caudal base, forked. Uniform brownish.

Megalaspis cordyla (Linné).

Two 228 to 230 mm.

Caranx sexfasciatus, Quoy and Gaimard.

Two 127 to 132 mm.

Caranx kalla, Valenciennes.

Two 140 to 160 mm.

Carangoides malabaricus (Schneider).

Three 117 to 198 mm. In my account of South African fishes 2 specimens have the straight section of the lateral line $1\frac{1}{2}$ in the arch and not the reverse as printed.[3] The Bombay examples show the straight section of the lateral line $1\frac{2}{5}$ to $1\frac{1}{2}$ in the arch.

Citula atropos (Schneider).

Depth $1\frac{4}{5}$; head $3\frac{1}{2}$, width 2. Snout $3\frac{1}{2}$ in head from snout tip ; eye 4, equals snout or $1\frac{1}{3}$ in interorbital ; maxillary reaches first third in eye, expansion $2\frac{1}{4}$, length $2\frac{1}{4}$ in head ; narrow band of short conic teeth in each jaw and small patch of villiform teeth on vomer, none on palatines or tongue ; interorbital $3\frac{2}{5}$ in head, elevated convexly with strong median keel to spinous dorsal. Gill-rakers 12 + 20, lanceolate, $1\frac{1}{8}$ in gill-filaments or $1\frac{2}{5}$ in eye.

Scales 34 + 36 in lateral line, 18 above arch to base of spinous dorsal, 33 below ; predorsal with median naked strip its entire extent ; breast and chest broadly naked to pectoral and ventral bases ; scales with 45 to 48 + 50 to 63 vertical parallel striæ ; arch of lateral line $1\frac{1}{2}$ in straight section. Dorsal I, VIII—I, I, 21, I, third erect spine $2\frac{3}{4}$ in total head, first branched ray $1\frac{2}{3}$; anal II—I, I, 19, I, first branched ray $1\frac{4}{5}$; least depth of caudal peduncle 5 ; caudal $3\frac{1}{2}$ in combined head and body to caudal base, forked ; pectoral $2\frac{2}{3}$, falcate ; ventral $3\frac{1}{2}$; vent midway in median abdominal groove in length of depressed ventral.

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[1] *Hist. Nat. Poiss.*, vol. 8, 1831, p. 277.
[2] *Fishes of Coromandel*, vol. 2, 1803, p. 29 pl. 137, Vizagapatam.
[3] *Proc. Acad. Nat. Sci. Phila.*, 1925, p. 216.

Back olivaceous brown, paler to whitish below. Iris gray. Dorsal and caudal pale brown, with spinous fin, soft dorsal edge above and stripe along each ray dotted with gray to dusky. Ventral neutral black. Anal and pectoral whitish.

One 217 mm. It agrees well with Russell's figure of *Maish parah*.[1] There are, however, no scales at the pectoral base in my example such as Russell shows. Also he does not indicate the small basal scales on the dorsal and anal or caudal, or on the lobes of these fins.

Apolectus niger (Bloch).

One 240 mm.

MENEIDÆ

Mene maculata (Schneider).

One 228 mm. Back drab brown with blue to neutral dusky spots. Sides and below silvery white.

RACHYCENTRIDÆ

Rachycentron canadum (Linné).

One 575 mm.

LACTARIIDÆ

Lactarius lactarius (Schneider).

Four 140 to 146 mm.

LEIOGNATHIDÆ

Leiognathus daura (Cuvier).

Depth $2\frac{1}{8}$; head $3\frac{1}{4}$, width 2. Snout $3\frac{1}{10}$ in head; eye $3\frac{1}{10}$, subequal with snout or interorbital; maxillary reaches opposite eye, expansion $3\frac{1}{2}$ in eye, length $2\frac{2}{5}$ in head; lower lip over twice width of upper; interorbital $2\frac{4}{5}$ in head, little elevated with depression medianly. Gill-rakers 6 + 14, lanceolate, $1\frac{1}{2}$ in gill-filaments which $\frac{1}{2}$ of eye.

Tubular scales about 60 + (pockets largely) in lateral line; scales very deciduous, most having fallen. Dorsal VIII, 16, I, second spine $1\frac{3}{5}$ in head, second ray $3\frac{1}{2}$; anal III, 14, I, second spine $1\frac{9}{10}$, second ray 4; caudal 1, well forked, lobes equal; least depth of caudal peduncle $4\frac{1}{3}$; pectoral $1\frac{1}{3}$; ventral 2.

Back drab gray, below paler to whitish. Traces of 10 pairs of darker vertical lines along edge of back. Snout end dark. Iris gray. Fins all pale, spinous dorsal terminally black. Pectoral base inside axil black.

One 94 mm. I also have a single example 80 mm. long from the Philippines for comparison. It shows:

Depth 2; head 3, width 2. Snout $2\frac{4}{5}$ in head; eye $3\frac{2}{5}$, $1\frac{1}{6}$ in snout, subequal with interorbital; maxillary reaches opposite front pupil edge, expansion 3 in eye, length $2\frac{1}{4}$ in head; teeth very minute, uniserial, obsolete in upper jaw; interorbital $3\frac{2}{3}$, convex, depressed medianly; supraorbital edge entire; lower preopercle edge denticulate, hind edge entire. Gill-rakers 7 + 21, lanceolate.

Scales very small, deciduous, absent from entire breast to pectoral and ventral bases. Lateral line little more arched than profile of back, extends midway along caudal peduncle side. Dorsal VIII, 16, I, second spine $1\frac{3}{5}$ in head; anal III, 14, I, second branched ray $1\frac{4}{5}$; caudal $1\frac{1}{10}$, forked, slender lobes pointed; caudal peduncle depth $4\frac{2}{5}$; pectoral $1\frac{2}{5}$; ventral $2\frac{1}{8}$.

Back drab gray, sides and below silvery white. Iris white. Snout sprinkled with dusky dots along front margin above lips. Fins pale brownish, spinous dorsal dusky marginally. Neutral dusky line along edge of back below dorsal base. Diffuse neutral dusky blotch about size of pupil at end of supraocular spine.

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[1] *Fishes of Coromandel*, vol. 2, 1803, p. 38, pl. 152, Vizagapatam.

Leiognathus fasciatus (Lacépède).

Depth $1\frac{4}{5}$; head $3\frac{1}{3}$, width 2. Snout $2\frac{4}{5}$ in head; eye $3\frac{1}{10}$, $1\frac{1}{8}$ in snout, $1\frac{1}{8}$ in interorbital; maxillary reaches opposite eye, expansion $3\frac{1}{2}$ in eye, length $2\frac{3}{4}$ in head; lower lip scarcely wider than upper; interorbital 3, little elevated, with broad median depression. Gill-rakers 7 + 14, lanceolate, $\frac{1}{2}$ of gill-filaments which $2\frac{1}{4}$ in eye.

Tubular scales 58 + (largely pockets) in lateral line; very deciduous, nearly all having fallen; breast naked to pectoral and ventral bases. Dorsal VIII, 16, I, second spine filamentous, $2\frac{1}{5}$ in combined head and body to caudal base, first ray $4\frac{1}{4}$ in head; anal III, 14, I, second spine 1, first ray $3\frac{2}{5}$; least depth of caudal peduncle 4; pectoral $1\frac{1}{3}$; ventral 2.

Back drab gray, paler to whitish below. Traces of a dozen or more obscure dark gray vertical lines. Iris deep gray. End of snout brown. Lips pale or whitish. Fins pale brown, inside pectoral axil blackish.

One 105 mm.

Gazza minuta (Bloch).

Five 64 to 137 mm. Three are much smaller than the others and with rather few obscure darker vermiculating lines.

ACROPOMATIDÆ

Acropoma japonicum, Günther

One 100 mm.

AMBASSIDÆ

Ambassis gymnocephalus (Lacépède).

Nine from pools in Back Bay, 43 to 62 mm.

SERRANIDÆ

Serranus lanceolatus (Bloch).

Three 51 to 150 mm. Larger two with mandibular teeth biserial or slightly triserial anteriorly. Dorsal XI, 14, I, to XI, 16, I; anal III, 8, I. Dark line in maxillary groove.

PRIACANTHIDÆ

Priacanthus hamrur (Forskål).

One 208 mm. Gill-rakers 6 + 21. Scales 65 + 4. Dorsal X, 13, I; anal III. 14, I; ventral $1\frac{1}{8}$ in head. Generally bright red. Lower anal edge dark gray, Ventral neutral dusky.

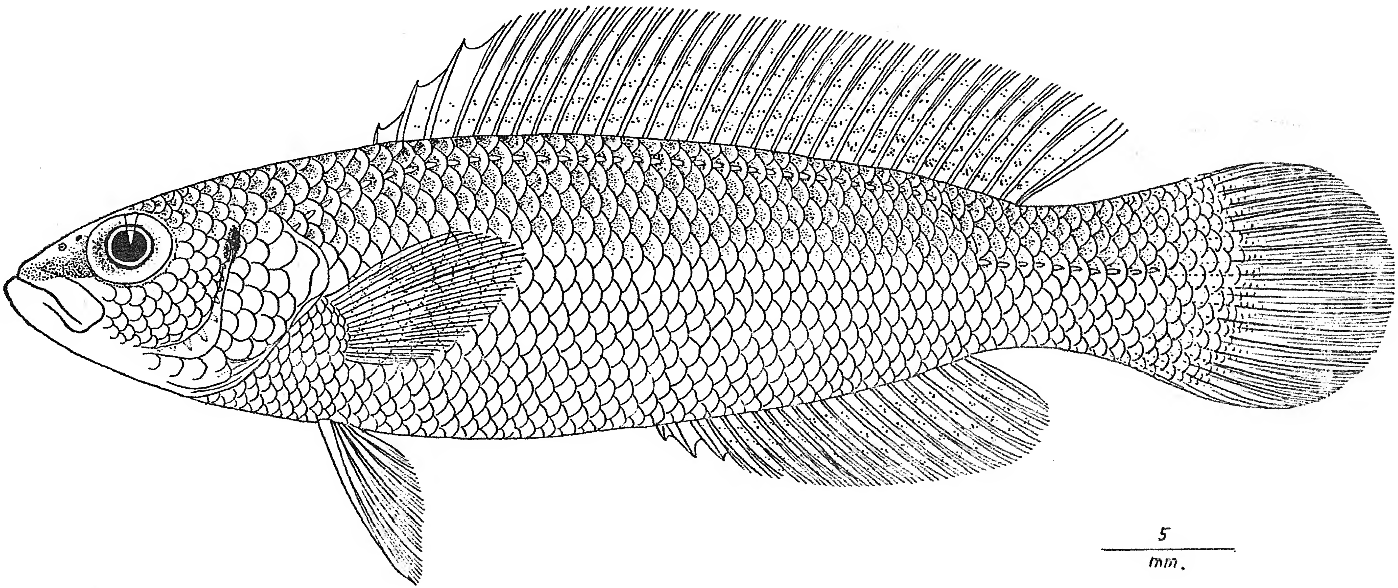
PSEUDOCHROMIDÆ

Pseudochromis spencei, new species

Plate I

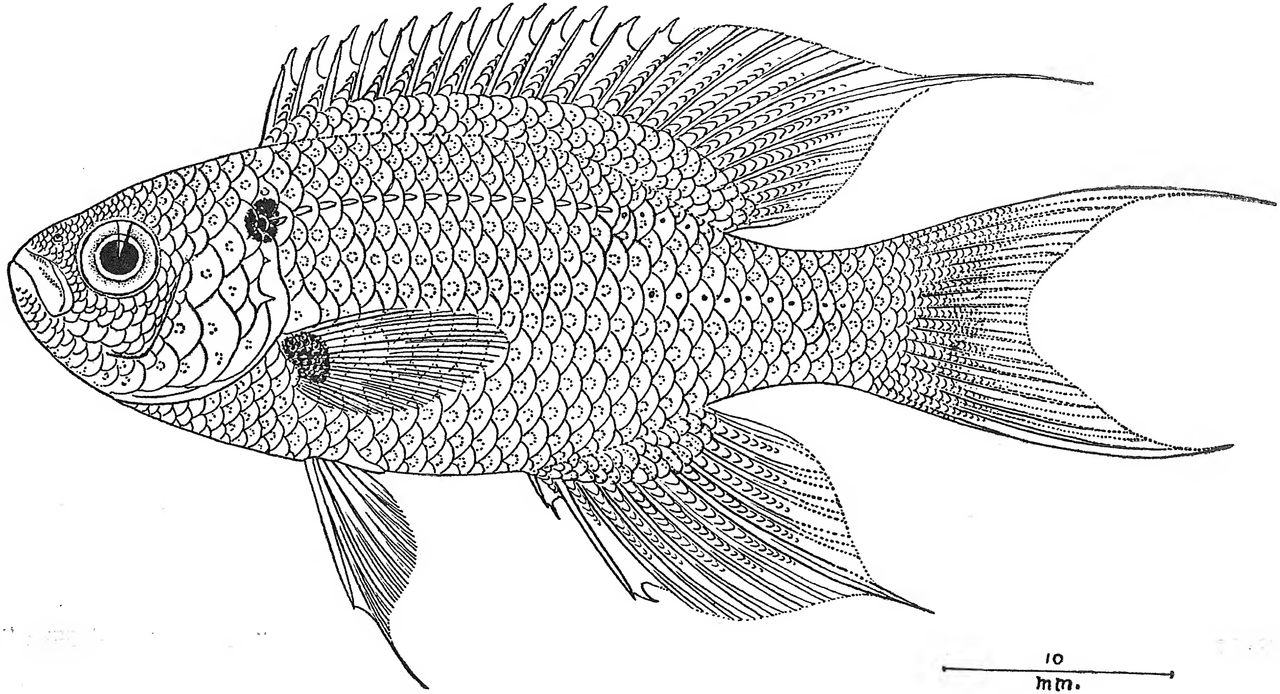
Depth $3\frac{4}{5}$; head $3\frac{1}{5}$, width $2\frac{1}{4}$. Snout $4\frac{2}{3}$ in head, from snout tip, little broader than long; eye $3\frac{3}{5}$ in head, greater than snout or interorbital; maxillary reaches slightly beyond front eye edge, expansion $2\frac{3}{4}$ in eye, length 3 in head; teeth conic, simple, uniserial in jaws, 4 canines in each anteriorly and small medio-lateral mandibular; no teeth on palate or tongue, latter pointed and free in front; interorbital $6\frac{1}{6}$ in head, slightly convex; preopercle edge entire; opercle ends in broad, short, free spine. Gill-rakers 5 + 10, lanceolate, $\frac{1}{2}$ of gill-filaments which $1\frac{2}{3}$ in eye.

Scales 36 + 8 + 2 in lateral line, 3 above, 14 below, 17 predorsal forward till midway in interorbital; 5 rows on cheek to preopercle ridge; muzzle naked; of fins only caudal scaled basally; scales with 11 basal radiatlng striæ, 57 apical denticles with 1 or 2 transverse series of basal elements, circuli fine. Dorsal III, 29, third spine $3\frac{3}{4}$ in total head length, third ray $2\frac{1}{3}$; anal III, 18,



Pseudochromis spencei, NEW SPECIES.

Henry W. Fowler, Del.



Pomacentrus prateri, NEW SPECIES.

Henry W. Fowler, Del.

second spine 6, eighth ray $2\frac{2}{3}$; caudal $1\frac{1}{5}$, convexly rounded behind ; least depth of caudal peduncle $2\frac{1}{4}$; pectoral $1\frac{3}{5}$; ventral $1\frac{4}{5}$.

Back brownish, below paler. In postocular, at upper juncture of preopercle short dusky bar size of pupil. Iris gray Under surface of head and body pale to whitish. Dorsals, caudal and anal pale gray Dorsal and anal with numerous, obscure, dark longitudinal lines.

Type, an example from pools in Back Bay, 53 mm. long. This species differs from *Pseudochromis xanthochir* Bleeker, reported from the Andamans by Day, in its slightly different fin formula, its uniform coloration and above all in its dark postocular blotch.

Dedicated to Sir Reginald Spence, Honorary Secretary of the Bombay Natural History Society.

LUTJANIDÆ

Lutjanus johnii (Bloch).

Three 134 to 158 mm., also 2 from Back Bay 73 to 74 mm. All with dorsal rays 13, I or 14, I. None show the usual dark blotch on the lateral line below the junction of the dorsal fins.

POMADASIDÆ

Pomadasis hasta (Bloch).

Three 125 to 310 mm.

THERAPONIDÆ

Therapon puta (Cuvier).

Young one from Back Bay pools 62 mm. long. For comparison I have 20 Philippine examples 80 to 112 mm. These show :—

Depth 3 to $3\frac{2}{3}$; head $2\frac{7}{8}$ to $3\frac{1}{4}$, width 2 to $2\frac{2}{5}$. Snout $3\frac{1}{4}$ to $3\frac{2}{5}$ in head ; eye $3\frac{1}{5}$ to $3\frac{2}{5}$, 1 to $1\frac{1}{10}$ in snout, little greater than interorbital, more so in young ; maxillary reaches opposite eye, length 3 to $3\frac{1}{5}$ in head ; teeth simple, conic, villiform, in bands in jaws, outer row little enlarged, none on palate ; interorbital 4 to $4\frac{1}{2}$, broadly convex ; preopercle with lower edge finely denticulate, few denticles around angle at margin, of which at least 3 enlarged and median $\frac{1}{2}$ of eye ; lower preorbital edge rough ; opercular spine $\frac{1}{2}$ of eye. Gill-rakers 9 + 20, lanceolate, subequal with gill-filaments or $\frac{1}{2}$ of eye.

Scales 80 + 8, 12 above, 24 below, 19 or 20 predorsal to occiput, 6 rows on cheek to preopercle ridge ; 8 or 9 basal radiating striæ, 10 to 12 apical denticles with 2 or 3 series of transverse basal elements and circuli fine. Dorsal XIII, 10, I, fifth spine $1\frac{1}{2}$ to $1\frac{3}{5}$ in head, first ray $1\frac{5}{6}$ to $2\frac{1}{10}$; anal III, 8, I, third spine $2\frac{1}{5}$ to $2\frac{1}{4}$, first ray $1\frac{3}{4}$ to $1\frac{9}{10}$; caudal $1\frac{1}{3}$ to $1\frac{2}{5}$, emarginate ; least depth of caudal peduncle 3 to $3\frac{1}{10}$; pectoral $1\frac{1}{2}$ to $1\frac{3}{5}$; ventral $1\frac{2}{5}$ to $1\frac{3}{5}$.

Back pale brown, below whitish. Iris whitish. Dark brown band begins over nostrils, runs over eye to bases of last dorsal rays ; second band from snout tip to eye and then along median body axis to caudal medianly to its hind edge. Dark or blackish band horizontally across each caudal lobe medianly. Spinous dorsal pale or whitish, with large black area over highest portion. Soft dorsal pale, with dusky apical margin. Other fins pale, lower whitish, anal sometimes with dusky median area.

Therapon jarbua (Forskål).

Three 128 to 245 mm.

LETHRINIDÆ

Lethrinus nebulosus (Forskål).

Depth $2\frac{1}{2}$; head $2\frac{7}{8}$, width $1\frac{7}{8}$. Snout $2\frac{1}{10}$ in head ; eye 4, $1\frac{9}{10}$ in snout, $1\frac{1}{3}$ in interorbital ; maxillary exposed, reaches opposite front nostril, length $2\frac{2}{3}$ in head ; teeth with outer enlarged row of which posterior 5 or 6 short, though broadly conic ; 2 front canines in each jaw : inner narrow band of villiform teeth, at least anteriorly in jaws ; interorbital $3\frac{1}{2}$, broadly convex. Gill-rakers 7 + 6, low broad tubercles, $2\frac{1}{2}$ in gill-filaments, which $1\frac{3}{4}$ in eye.

Scales 46 + 5, 7 above, 17 below, 8 predorsal ; 17 to 19 basal radiating striæ, 82 to 89 apical denticles with 12 to 13 transverse series of basal elements and circuli fine. Dorsal X, 9, I, fourth spine $2\frac{3}{4}$ in head, first ray 3 ; anal III, 8, I, second spine $3\frac{1}{4}$, first ray $2\frac{7}{8}$; caudal $1\frac{1}{5}$, deeply forked : least depth of caudal peduncle 3 ; pectoral $1\frac{1}{8}$; ventral $1\frac{2}{3}$.

Drab brown, little paler on under surface of head and belly. Cheek with some small obscure dark spots. Traces of 3 or 4 nearly vertical dark bands which inclined little backward and apparently some intervening parallel narrower streaks. Iris slaty. Inside mouth orange red. Fins all dull brown, dorsal and anal with several obscure rows of dark spots longitudinally. Caudal also with traces of several dark cross bands. Pectoral pale brown. Ventral largely neutral dusky terminally, at least on membranes.

One 175 mm.

SPARIDÆ

Sparus datnia (Buchanan-Hamilton).

Depth $2\frac{1}{4}$; head $2\frac{7}{8}$, width 2. Snout $2\frac{4}{5}$ in head ; eye $4\frac{1}{3}$, $1\frac{2}{5}$ in snout, $1\frac{2}{5}$ in interorbital ; maxillary reaches $\frac{2}{5}$ in eye, expansion 2, length $2\frac{1}{2}$ in head ; 6 conic canines in front of each jaw ; 3 rows of molars each side below and 4 rows each side above, next to innermost posteriorly with broadest or largest teeth ; interorbital $3\frac{2}{5}$, broadly convex ; infraorbital depth to maxillary end $1\frac{1}{2}$ in eye ; preopercle edge entire. Gill-rakers 5 + 11, short compressed points, $3\frac{1}{2}$ in gill-filaments which $1\frac{2}{5}$ in eye.

Scales 41 + 6, 6, above, 12 below, 18 predorsal to middle of interorbital ; 6 rows on cheek ; suprascapula entire ; 11 basal radiating striæ, about 90 weak apical denticles with 6 distinct transverse series of basal elements and circuli very fine. Dorsal XII, 10, I, spines strong, third 2 in head, first ray $2\frac{3}{5}$; anal III, 8, I, second spine enlarged, $1\frac{2}{3}$, first ray $2\frac{1}{5}$; caudal $1\frac{1}{5}$, deeply forked ; least depth of caudal peduncle $2\frac{1}{2}$; ventral $1\frac{1}{3}$; pectoral $2\frac{1}{2}$ in combined head and body to caudal base.

Brown over back and above, head, belly and under surface of tail whitish. Iris gray. Suprascapular region and upper hind part of opercle dusky brown. Dorsals, caudal and pectorals brownish, membranes of fins terminally neutral dusky, more broadly so on spinous dorsal. Anal and ventral whitish

One 237 mm. Distinguished chiefly by its enlarged second anal spine, which long as combined eye and postocular part of head.

Pagrus major (Schlegel).

Depth $1\frac{9}{10}$; head $2\frac{7}{8}$, width 2. Snout 2 in head ; eye $3\frac{7}{8}$, $1\frac{7}{8}$ in snout, $1\frac{1}{8}$ in interorbital ; maxillary reaches first fourth in eye, expansion $2\frac{1}{4}$, length $2\frac{2}{5}$ in head ; 4 conic upper canines, 6 lower, anteriorly in jaws ; 3 rows of molars above and 2 below in each jaw each side ; interorbital $3\frac{3}{5}$ in head, convexly elevated ; eye $1\frac{1}{3}$ in preorbital width, which $2\frac{7}{8}$ in head ; preopercle edge entire. Gill-rakers 6 + 11, low points, which $\frac{1}{4}$ of gill-filaments, last $1\frac{1}{3}$ in eye.

Tubular scales 53 in lateral line to caudal base, 7 above, 16 below, 13 predorsal to occiput though very small scales extend forward to front of interorbital ; 6 rows on cheek to preopercle ridge. Dorsal XI, 10, I, fourth spine 3 in head, first ray $3\frac{1}{4}$; anal III, 8, I, third spine $3\frac{1}{8}$, first ray $3\frac{1}{5}$; caudal $1\frac{1}{5}$, deeply forked; least depth of caudal peduncle $2\frac{4}{5}$; ventral $1\frac{1}{2}$; pectoral $2\frac{2}{5}$ in combined head and body to caudal base.

Light brown generally, with mauve to gray tints on head and back. Some very small pale grayish spots or dots obscurely on snout. Iris gray white. Fins all pale brownish.

One 328 mm. I have followed Jordan and Thompson in accepting this as a distinct species[1] from the closely related *Pagrus auratus* (Schneider). It has apparently not been reported from India previously.

Dentex japonicus (Bloch).

Two 210 to 222 mm. to ends of caudal filaments.

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[1] *Proc. U. S. Nat. Mus.*, 47, 1912, p. 576.

GERRIDÆ

Gerres lucidus, Cuvier.

Four 83 to 88 mm.

Gerres filamentosus, Cuvier.

One 156 mm.

MULLIDÆ

Upeneoides sulphureus (Cuvier).

Depth 3 to $3\frac{1}{5}$; head 3 to $3\frac{1}{5}$, width $1\frac{7}{8}$ to 2. Snout $2\frac{1}{5}$ to $2\frac{1}{4}$ in head; eye $4\frac{1}{8}$ to $4\frac{1}{4}$, $1\frac{3}{4}$ to 2 in snout, $1\frac{1}{8}$ in interorbital; teeth small, short, in narrow bands in jaws in 4 or 5 irregular series, none on palate or tongue; maxillary reaches opposite eye, expansion $1\frac{1}{2}$ in eye, length $2\frac{3}{5}$ in head; interorbital $3\frac{1}{3}$ to $3\frac{2}{3}$, scarcely elevated, depressed medianly. Gill-rakers 10 + 20, lanceolate, $1\frac{1}{2}$ in gill filaments which $1\frac{1}{8}$ in eye.

Scales 33 + 4 or 5, 3 above, 7 below, 14 or 15 predorsal, 3 rows on cheek to preopercle ridge; 5 basal radiating striæ, 107 to 119 apical denticles with 9 to 15 transverse series of basal elements and circuli minute. Dorsal VIII–I, 8, I, second spine $1\frac{1}{2}$ to $1\frac{3}{5}$ in head, first branched ray 2 to $2\frac{1}{8}$; anal I, 6, I, first ray $2\frac{1}{10}$ to $2\frac{1}{5}$; caudal $1\frac{1}{8}$ to $1\frac{1}{5}$, well forked; least depth of caudal peduncle $2\frac{7}{8}$ to 3; pectoral $1\frac{1}{5}$ to $1\frac{1}{4}$; ventral $1\frac{3}{5}$ to $1\frac{4}{5}$.

Pale brown, little lighter below. Iris gray brown. Fins all pale. Spinous dorsal with black apex and median horizontal dusky band. Soft dorsal with dusky margin above and median longitudinal dark band.

Three 154 to 169 mm.

SCIÆNIDÆ

Otolithes ruber (Schneider).

Three 173 to 195 mm. All with maxillary reaching at least last fifth in eye.

Collichthys brunneus (Day).

Depth $4\frac{1}{2}$ to $5\frac{1}{5}$; head $3\frac{1}{8}$ to $3\frac{1}{2}$, width 2 to $2\frac{1}{8}$. Snout 4 to $4\frac{3}{5}$ in head from snout tip; eye $6\frac{3}{5}$ to $7\frac{3}{5}$, $1\frac{3}{4}$ to 2 in snout, $1\frac{7}{8}$ to $2\frac{1}{2}$ in interorbital; maxillary reaches well beyond eye or length $2\frac{1}{10}$ to $2\frac{1}{2}$ in head; teeth above in villiform band with outer row of enlarged teeth, of which most anterior appear as pair of slightly larger wide set canines; lower teeth as row of small inconspicuous outer row and an inner row of enlarged ones, with 2 anterior rather close set and slightly more canine like, though 3 or 4 median lower laterals largest in jaw; interorbital $3\frac{2}{3}$ to $4\frac{1}{5}$, broadly convex; preopercle edge membranous, with serrated points. Gill-rakers 7 + 11, lanceolate, $1\frac{1}{2}$ in gill-filaments which $1\frac{1}{8}$ in eye.

Scales 56 to 61 + 27, 14 above, 11 below, 50 predorsal; 11 on cheek to preopercle ridge; scales rather larger on head, fine on predorsal to occiput and along dorsal and ventral edges of body; 7 to 15 basal radiating striæ, 7 to 10 very small weak apical denticles in 3 to 5 transverse series and complete circuli fine. Dorsal X, 28, I or 29, I, fourth spine $2\frac{7}{8}$ to $3\frac{1}{8}$ in head, first ray 3 to $3\frac{1}{5}$; anal II, 6, I, second spine $5\frac{1}{4}$ to $5\frac{3}{5}$, second ray $2\frac{1}{3}$ to $2\frac{3}{4}$; caudal 1 to $1\frac{3}{5}$, ends in median point behind; least depth of caudal peduncle $4\frac{4}{5}$ to $5\frac{1}{5}$; pectoral $1\frac{1}{3}$ to $1\frac{3}{5}$; ventral $1\frac{9}{10}$ to $2\frac{1}{10}$.

Drab brown with dusky tint, but little paler below or on under surfaces, even these smutty. Iris dark gray. Dorsals, caudal and anal largely dark gray, neutral dusky or blackish terminally.

Two 175 to 275 mm.

Johnius diacanthus (Lacépède).

One 308 mm. Five broad dark transverse bands on back and sides. Whole body with more or less soiled or smutty shade. Soft dorsal and caudal spotted with darker. Anal and paired fins dark gray.

Johnius sina (Cuvier).

Five 122 to 208 mm. Although Day gives 8 scales above the lateral line his figure of *Sciæna sina* shows but four.

This species is noticed by me, but made to read wrongly under *Johnius diacanthus* (Lacépède).[1] The heading '*Johnius sina* (Cuvier)' should have been placed at line 48 as was indicated in the corrected proof. The earlier *Argyrosomus* De la Pylaie will replace the subgeneric name *Pseudosciæna* Bleeker. Int he same paper at the beginning of line 10, under *Johnius æneus* Bloch, add 'eye $4\frac{1}{6}$ to 5, $1\frac{1}{5}$ to $1\frac{1}{4}$ in snout.'

SILLAGINIDÆ

Sillago ihama (Forskål).

Three 98 to 165 mm.

EPHIPPIDÆ

Drepane punctata (Linné).

Two 148 to 177 mm.

SIGANIDÆ

Siganus rivulatus (Forskål).

One 150 mm.

PLATYCEPHALIDÆ

Thysanophrys crocodilus (Tilesius).

Depth 6; head $2\frac{1}{2}$, width $1\frac{3}{5}$. Snout $3\frac{1}{5}$ in head from snout tip; eye $7\frac{1}{5}$, $2\frac{1}{5}$ in snout, little greater than bony interorbital; maxillary reaches slightly beyond front of eye, expansion 2 in eye, length $2\frac{2}{3}$ in head; teeth villiform, in broad bands in jaws, small patch each side of vomer and narrow band along each palatine; bony interorbital $1\frac{1}{5}$ in eye, flat, eyes protruding little above each side; 2 preopercle spines, upper little larger or about half of eye. Gill-rakers 2 + 4, lanceolate, slightly less than gill-filaments or $1\frac{4}{5}$ in eye.

Scales 100 + 7 in lateral line, 8 above to spinous dorsal orgin, 18 below, 17 predorsal to occiput. Dorsal I, VIII–I, 10, I, third spine $2\frac{1}{3}$ in total head length, first branched ray $3\frac{1}{8}$; anal I, 10, I, first branched ray $4\frac{3}{8}$; caudal $1\frac{9}{10}$, rounded behind, though uppermost rays end in protruded point above; least depth of caudal peduncle $7\frac{1}{5}$; pectoral $2\frac{1}{8}$; ventral $1\frac{2}{3}$.

Brown above, lighter or soiled brown below and under surface of head whitish. At last dorsal spines and front of soft dorsal large deeper brown saddle like blotch and another below posterior dorsal rays. Back and upper surface of head with small scattered dusky brown spots. Dark blotch below eye. Iris slaty. Dorsal greenish olive basally, neutral dusky terminally. Anal whitish. Caudal brown, clouded darker. Pectoral neutral dusky, with small scattered obscure dark spots. Ventral dusky, olivaceous basally, spine paler.

One 417 mm. Also one from the Philippines, 208 mm. It shows:—

Depth $8\frac{3}{4}$; head $2\frac{7}{8}$, width 2. Snout $3\frac{1}{5}$ in head from snout tip; eye $5\frac{1}{8}$, $1\frac{3}{4}$ in snout, over twice interorbital; maxillary reaches front pupil edge, length $1\frac{2}{3}$ in head; broad bands of granular teeth in jaws and small narrow bands on vomer and palatines, interorbital 11, deeply concave; antero-supraorbital spine, 4 above posterior half of eye with last longest; single occipital spine each side; small postocular spine little elevated, followed by 3 above opercle and long spine at suprascapula; 2 small infraorbitals on suborbital stay, also another spine at angle which $\frac{1}{2}$ of eye, besides much shorter one close below; opercle with 2 moderate spines. Gill-rakers 1 + 5, lanceolate.

Scales 110 + 8, tubes 56 + 3, 8 above to soft dorsal origin, 18 below and 14 predorsal; 8 rows on cheek to preopercle ridge at angle; 7 or 8 basal radiating striæ, 23 to 31 apical denticles with 5 to 7 transverse series of basal elements and circuli fine. Dorsal I, VIII, I, 10, I, third spine $2\frac{1}{8}$ in total head length, first branched ray $2\frac{1}{2}$; anal I, 10, I, first ray $4\frac{2}{3}$; caudal 2, slightly convex behind; least depth of caudal peduncle 7; pectoral $2\frac{1}{2}$; ventral $1\frac{1}{2}$.

[1] *Journ. Bom. Nat. Hist. Soc.*, November 1926, p. 9.

Brown above, whitish below. Iris gray. Spinous dorsal light brown, with several dark brown spots on each ray. Caudal brown, with several of outer membranes very dark brownish or blackish. Anal pale. Paired fins light brown, darker terminally.

Thysanophrys scaber (Linné).

Depth 8; head $2\frac{2}{10}$, width 2. Snout $3\frac{1}{2}$ in head from snout tip; eye 7, 2 in snout, little greater than bony interorbital; maxillary reaches slightly beyond front of eye, expansion $2\frac{1}{3}$ in eye, length $2\frac{3}{5}$ in head; teeth villiform, in broad bands in jaws, small patch each side of vomer and narrow band along each palatine; bony interorbital $1\frac{1}{3}$ in eye, little concave; preopercle spine 4 in head, very short one below. Gill-rakers 1 + 7, lanceolate, equal gill-filaments or $1\frac{1}{5}$ in eye, also 4 rudimentary tubercles above and 9 below.

Spinous scales 53 in lateral line to caudal base, scales along lateral line 88 + 6, 5 above to spinous dorsal origin, 16 below, 10 predorsal to occiput. Bones on top of head more or less rugosely striate. Dorsal I, VIII, I, 11, I, third spine $2\frac{3}{5}$ in total head length, first branched ray $2\frac{3}{5}$; anal I, 12, I, first branched ray $4\frac{3}{5}$; caudal $1\frac{9}{10}$, forming median obtuse angle behind; least depth of caudal peduncle 7; pectoral $2\frac{3}{5}$; ventral $1\frac{4}{5}$.

Brown above, obscurely mottled darker. Under surface of body whitish. Irish slaty. Spinous dorsal neutral dusky, large black blotch on last 2 membranes terminally. Soft dorsal dull gray with darker blotches or spots. Caudal with upper and lower edges narrowly pale, fin otherwise dark gray, more or less dusky terminally. Pectoral brownish, finely spotted with dusky gray. Ventral neutral blackish, front and hind edge narrowly whitish.

One 217 mm.

Thysanophrys macracanthus (Bleeker).

Depth $7\frac{1}{2}$; head $2\frac{1}{2}$, width $2\frac{1}{3}$. Snout $3\frac{1}{8}$ in head from snout tip; eye 4, $1\frac{1}{4}$ in snout, nearly 3 times interorbital; maxillary reaches opposite first third in eye, expansion $2\frac{1}{2}$ in eye, length $2\frac{1}{4}$ in head; teeth viliform, in bands in jaws, small patch on vomer and narrow band on each palatine; interorbital $2\frac{4}{5}$ in eye, concave; preopercle spine $1\frac{1}{3}$ in eye, nearly long as its distance from eye. Gill-rakers 2 + 5, lanceolate, upper inner edge spinescent, long as gill-filaments which $2\frac{1}{4}$ in eye.

Tubular scales 44 + 3 in lateral line, large, simple, though not armed with scutes, likely a condition of youth? Scales very fine, 10 above lateral line, 15 below, 16? predorsal to occiput; cranium largely scaly, head otherwise naked. Dorsal I, VIII, I, 10, I, fourth spine 3 in total head length, second branched ray $2\frac{3}{5}$; anal 11, third ray $4\frac{1}{3}$; caudal $1\frac{9}{10}$, obtuse or truncate; least depth of caudal peduncle $8\frac{1}{4}$; pectoral $2\frac{1}{3}$; ventral $2\frac{1}{8}$.

Back brown, sides with gray and lower surface whitish. Obscure transverse brownish band across middle of occiput. Dark brown transverse band or saddle like blotch from last half of spinous dorsal. Another at last half of soft dorsal. Iris slate gray. Spinous dorsal neutral blackish on each membrane medially. Soft dorsal and caudal grayish, with terminal dusky band and large transverse basal dusky blotch on caudal. Anal whitish. Paired fins blackish.

One 40 mm.

Pomacentrus prateri, new species.

Plate II

Depth $2\frac{1}{2}$; head 3. width $1\frac{4}{5}$. Snout $3\frac{1}{2}$ in head from snout tip; eye $3\frac{1}{2}$, subequal with snout or interorbital; maxillary extends but very slightly beyond front of eye, expansion $2\frac{4}{5}$ in eye, length $3\frac{1}{4}$ in head; teeth small, compressed, anterior in each jaw at least uniserial incisors, laterals more pointed; interorbital $3\frac{1}{2}$ in head, convex; preopercle edge minutely serrated. Gill-rakers 7 + 13, lanceolate.

Tubes 16 in upper section of lateral line followed by 4 pores and 9 pores in horizontal section to caudal base; 3 scales above lateral line, 9 below, 18 predorsal forward opposite nostril; 4 rows on cheek, of which uppermost on preorbitals and suborbitals, which without lower edges free, also lowest row on

preopercle flange; muzzle, including maxillary, naked. Scales with 6 to 8 basal radiating striæ, 72 to 79 apical denticles and 4 to 6 transverse series of basal elements, circuli fine. Dorsal XIII, 11, I, third spine 2 in head, margin of membranes of spines deeply incised, fifth ray 2⅗ in combined head and body to caudal base; anal II, 10, I, second spine 2⅓ in head, fifth ray 2; last depth of caudal peduncle 2⅓; pectoral 1⅓; ventral 1; caudal 2⅓ in combined head and body to caudal base, deeply lunate, each tip ending in filament.

Dusky brown, back quite dark. On trunk and tail many of scales each with minute apical gray white dot. Iris gray. Dorsals neutral dusky to blackish, posteriorly margined whitish. Anal similar. Caudal dusky black, broadly to whitish margin behind. Pectoral gray, with blackish brown blotch nearly size of pupil at base, also slightly smaller suprascapular dusky blotch. Ventral blackish.

Type a single example from Back Bay, 52 mm. long. It is suggestive of *Pomacentrus violescens* (Bleeker) and largely agrees with Bleeker's figure, except the caudal peduncle and caudal fin not pale.

Named after Mr. S. H. Prater, Curator of the Bombay Natural History Society.

CALLYDONTIDÆ

Callyodon dubius (Bennett).

One 146 mm.

ELEOTRIDÆ

Butis caperatus (Cantor).

One 75 mm.

GOBIIDÆ

Glossogobius biocellatus (Valenciennes).

Six 68 to 131 mm.

Rhinogobius griseus (Day).

Six 63 to 73 mm.

Rhinogobius viridipunctatus (Valenciennes).

One 89 mm.

Bathygobius fuscus (Rüppell).

Two 68 to 69 mm.

Gobius ornatus, Rüppell

Five 58 to 94 mm. The type of *Gobius venustulus*, Fowler is synonymous as I find on comparison.

Oxyurichthys tentacularis (Valenciennes).

One 59 mm.

PSETTODIDÆ

Psettodes erumei (Schneider).

One 365 mm.

BOTHIDÆ

Pseudorhombus arsius (Buchanan-Hamilton).

One 280 mm.

SOLEIDÆ

Cynoglossus macrolepidotus (Bleeker).

Two 280 to 283 mm.

TRIACANTHIDÆ

Triacanthus brevirostris, Schlegel.

Depth $2\frac{3}{5}$; head $3\frac{1}{2}$, width 2. Snout $1\frac{1}{3}$ in head; eye 4, $2\frac{1}{3}$ in snout, $1\frac{3}{4}$ in interorbital; mouth width 4 in head; interorbital, $2\frac{2}{3}$ convexly elevated. Gill-opening $2\frac{2}{3}$ in head.

Skin coriaceous, granules rather smooth. Dorsal IV—25, first spine $1\frac{1}{8}$ in head, sixth ray $3\frac{1}{2}$; anal 17, fourth ray $2\frac{1}{2}$, anteriorly forms moderate lobe; caudal $1\frac{1}{5}$, widely forked; caudal peduncle depth 6 in its length or $7\frac{1}{2}$ in head; pectoral 2 $\frac{4}{5}$; ventral spine $1\frac{1}{3}$.

Back brownish, whitish below. Large dull dusky blotch on side of snout, also little dark above each eye in interorbital. Dark blotch about base of spinous dorsal and fin with basal $\frac{3}{5}$ blackish. Body otherwise pale. Iris gray. Lips pale.

One 280 mm.

TETRODONTIDÆ

Sphæroides oblongus (Bloch).

Depth (collapsed) $3\frac{4}{5}$; head $2\frac{3}{5}$, width $1\frac{1}{3}$. Snout $2\frac{1}{4}$ in head; eye $4\frac{2}{5}$, 2 in snout, $2\frac{1}{5}$ in interorbital; mouth width $4\frac{1}{4}$; lips moderate, feebly papillose; interorbital $2\frac{1}{5}$, but slightly elevated, broadly level medianly; each nasal papilla rather large, with 2 nostrils. Gill-opening $4\frac{3}{5}$ in head.

Predorsal spinescent area forward to nostrils and laterally not extending below eye except on postocular. Abdomen entirely spinescent below, from chin to vent. Dorsal III, 10, first branched ray 2 in head; anal III, 8, first branched ray $1\frac{4}{5}$; caudal peduncle $3\frac{1}{3}$; pectoral $2\frac{1}{10}$.

Back and head with dusky brown reticulations forming rounded gray spots and laterally on head and trunk as short dusky brown superior bars, on tail superiorly as few rather large dark reticulations. Lower sides and under surface of body whitish. Iris light gray. Fins whitish, caudal becoming dusky terminally.

One 61 mm.

GAME PRESERVATION AND GAME EXPERIMENTS IN INDIA[1]

BY

BERNARD C. ELLISON, F.R.G.S., C.M.Z.S., F.L.S.

(*With three plates*)

In British India the Game Preservation problem is coming to the fore and seems likely to become increasingly important, as is shown by a review which appeared this year in the *Times of India*, and the comprehensive article on the subject by the Editors of the *Bombay Natural History Society's Journal*, (vol. xxxii, p. 359,) where it was pointed out that, while on the whole the present condition of game in India is good, there has been a serious disappearance in some areas.

The authors maintained that, if game in the reserved forests and sanctuaries is to be protected, more rigid application of the laws is necessary. The whole question of game protection and the tightening up of the laws affecting it, appears to be mainly a question of money. In regard to British territory the articles advocated the formation of a special game protection fund in the various provinces as being worth considering. Sportsmen should contribute towards it and when one considers what must be paid for sport in other countries, this suggestion is not likely to be opposed seriously in India. A special charge might also be made for shooting the more sought-after species of game.

The formation of the fund might be sanctioned by local Governments and be applied to purposes of supplementing the rewards of forest guards, poisoning wild dogs and vermin and improving scanty water supplies. Such measures might not maintain wild life at its present level, but they might help to retard the process of depletion now observed. This is how the matter stands to-day in British India.

EXPERIMENTS IN PATIALA

For many years I have followed with great interest the game experiments of H. H. the Maharaja of Patiala and have twice been His Highness's guest at his State in the plains, and for several years have had an invitation to stay and shoot at Chail. Up till lately I have never had an opportunity of being able to avail myself of the Maharaja's hospitality in the hills.

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[1] Some notes compiled after a visit to the Reserves of H. H. the Maharaja of Patiala on the conclusion of my term of office as Game Warden of the State of Bhopal.

Being up in Simla in August 1927, I had my long-cherised wish fulfilled of visiting the summer capital of the ruler of the premier State in the Punjab.

It gave me all the more pleasure to go to Chail on account of my own interest in game preservation and game experiments.

After this visit I must assert that His Highness of Patiala, more than any other prince in India, has gone in for strict game preservation and is deeply interested in game experiments of all kinds. He is without doubt the keenest and most knowledgable sportsman and naturalist to-day among all the rulers in Hindustan. He has applied his knowledge, not only as regards the preservation of the fauna of his vast territories, but has gone in for experiments as regards introducing animals and birds not indigenous to his State.

My visit was in the rainy season, when the mountain ranges were covered for the most part with dense clouds and mist. There were only occasional times when the weather was bright and clear. It was the close season for shooting, nevertheless my time spent was most pleasant and by no means devoid of natural history incident.

What interested me in particular in coming up to Chail was to see actually the result of the Maharaja's experiment in introducing English pheasants into his territory, as I had some views on the subject myself. I had very many talks to His Highness about pheasants and other matters connected with zoology, game and shikar and was astonished at his broad views, not only on the pheasant question and game matters in general, but also on the scientific aspects and the far-reaching results of such experiments.

About the question of introducing non-indigenous animals and birds into India, we both held similar views. The successful experiments which His Highness has undertaken, beginning always in a small way, and which I am going to speak about, show the boundless possibilities there are in a large state in India such as Patiala.

His Highness evinces such keenness in the subject that it was a great pleasure to talk to such an enthusiast. Together we looked through the wonderful books on Pheasants of that remarkable ornithologist William Beebe, who presents such accurate information in such popular form. Would that there were more books written on natural history subjects, so readable, so instructive and withal accompanied by such beautiful illustrations and photographs. His Highness possesses all Beebe's books (editions de luxe), containing the accounts of the author's experiences, while tracking rare pheasants in Ceylon, Burma, the Western Himalayas, the Malay Peninsula and Sarawak. All the volumes are well used as testified by the book marks in them, and by the way the Maharaja is able to find immediately whatever he wants when referring to them.

In addition to these talks, I thoroughly examined the pheasantries in company with his most efficient Superintendent of Shikar, Mr. W. M. Hutton, whom I have known and been in constant correspondence with, ever since the Prince of Wales's tour of India, when he

(Mr. Hutton), so ably made all the shooting arrangements for the royal visit to Patiala. Also I went round the forests with Mr. J. A. Beaty, a retired police official, who has lately been appointed Game Preservation Officer in Patiala State. I was most enthuiastic about everything I saw, and am confident that this pheasant experiment is the prelude to much success in the future.

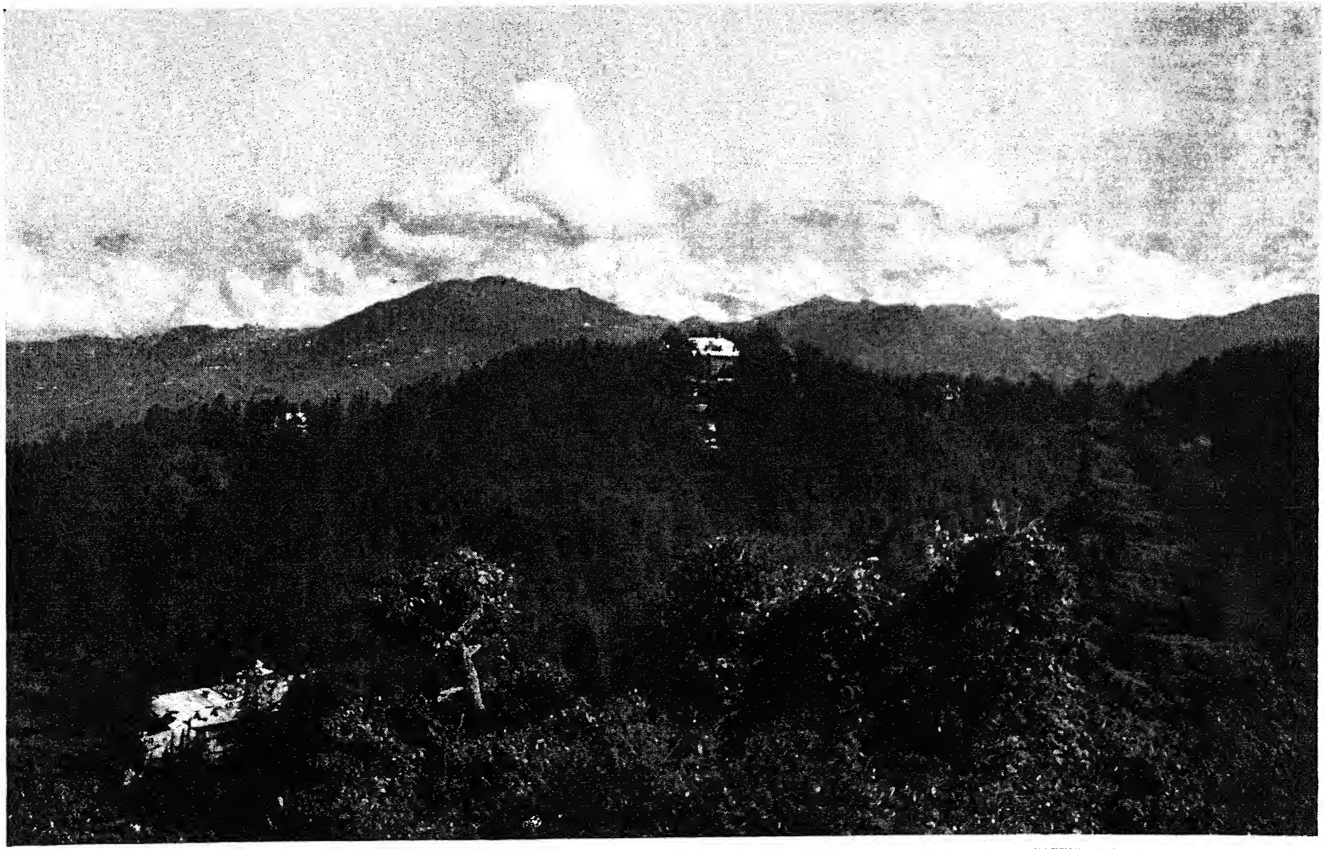
THE NATURAL HISTORY OF CHAIL AND THE FORESTS IN THE VICINITY.

A break in the rains on the morning of August 7 enabled me to ride into the jungles in the neighbourhood of the pheasantry which is in process of being made. This latter place is situated on the slopes of the mountains and is about two and a quarter miles in extent. It faces the Maharaja's palace, which lies two miles away on the summit of one of the southern sides of a mountain directly opposite Simla, and in front of the great snow barriers of the Himalaya. Most of the mountains round about range from 6,000 feet to 9,000 feet in height. Kufri, which is quite near, and a famous game reserve in use for entertaining Viceroys and distinguished sportsmen, reaches the latter height. Near Chail is Sidhbaba, the summit of the mountain: here is laid out the highest cricket ground in the world.

The country round about is well-wooded and consists mostly of magnificent conifers—*Pinus longifolia* and *Pinus excelsa* being very common. Oak, holly, rhododendrons and very many of the trees one meets at home in England abound everywhere. The rhododendrons must present a splendid sight when they are in bloom. In all the district round about they generally have widespreading arms and rugged branches and seldom exceed thirty or forty feet in height.

Everywhere round Chail is a paradise for Himalayan game. Black Bear (*U. torquatus*), Musk Deer (*M. moschiferus moschiferus*), Barking Deer (*C. muntjac*), Goral (*C. goral*), and Leopard (*F. pardus*), are among some of the animals which are very common. In addition to the ordinary birds, Cheer (*C. wallichi*), and Kalij Pheasants (*G. albicristatus*), are found; occasionally Monal (*L. refulgens*) come down from the higher altitudes during the heavy snow falls in winter. Chukor (*C. chucar*) are very plentiful and have increased tremendously since game preservation steps have been taken and of late years have spread round Chail more than in any other state adjoining Simla. Black Partridges (*F. vulgaris*) are very common and Peura or Hill Partridges (*Arboricola* sp.) have multiplied since 1918 so that these jungles everywhere are full of them.

I know myself how when going along the Kufri road with a dog I put up half a dozen of these birds every twenty yards. In this district of the Himalaya there are probably more Peura Partridges to be found to-day than in the lower parts of the Terai and the United Provinces. Years ago they were not at all common: their increase is entirely due to the Maharaja of Patiala introducing some years ago a hundred pairs of these birds from Nepal.



THE SUMMER PALACE OF THE MAHARAJAH OF PATIALA AT CHAIL IN THE HIMALAYAS.

In the jungles in the vicinity, His Highness has conducted a successful experiment as regards the introduction, acclimatization and breeding of English Pheasants.

HISTORY OF PHEASANT EXPERIMENTS IN THE SIMLA HILLS.

Before describing the actual pheasantry at Chail it might be of interest to give some history of the events which led up to the present experiment.

About thirty years ago the late Sir W. Buck got out fifty pheasants from England and put them down in the vicinity of Mashobra in the hills about seven miles from Simla. The birds however disappeared and people thought that the Indian pheasants had driven them away. The experiment therefore ended here.

In 1907 Lord Minto and Lord Kitchener decided to make an attempt to rear Kalij Pheasants (*Gennæus hamiltoni*) in the catchment area which lies some five or six miles from Simla. The author of *Simla Past and Present*, Mr. Edward J. Buck, C.B.E., says:—

> "The place was strictly preserved. The aid of forest officials was enlisted, eggs were collected for the purpose from all the neighbouring states, hens were brought to sit on the eggs and Gurkhas to guard the nests were specially engaged. But alas many of the four or five hundred eggs which arrived were 'addled', and less than thirty young pheasants made their appearance. Most of these on being eventually turned out became victims to the foxes, jackals, pine martens and other enemies which apparently appreciate unsophisticated youthful pheasants. So the result was that when the Viceroy and Chief shot the valley in October with a party of seven guns associated by numerous beaters and dogs, only fourteen pheasants and a 'karkar' were brought to bag. At a moderate guess each bird must have cost Rs. 100, and the attempt to raise more pheasants was discontinued."

Before any game experiment can be tried, arrangements must be made for destroying vermin—the most necessary precaution of all. This was a point I stressed very much in a *Game Warden's Report* I wrote in Bhopal. The neglect of this precaution was the main reason why the first Simla experiments in reference to pheasants were a failure; the birds straying into adjoining territory, where they were shot by poachers or killed by vermin. It is simply courting trouble to let birds loose in the jungles, without having made arrangements for preservation by destroying vermin.

THE PATIALA PHEASANT EXPERIMENT

In the years immediately preceding the Great War, the Maharaja of Patiala first began to be interested, and to see the possibilties, in reference to raising pheasants in his territories. He very wisely did not at first attempt anything on a large scale in his jungles, but merely contented himself with trying to find out if pheasants would thrive in his forests. A start was made with Mongolian Ringed, Crawford Silver, and Chinese Golden Pheasants (*P. pictus*) and also Monal (*L. impejanus*) and Western Tragopan (*T. melanocephalus*). From these it was found that the Monal did the best. Chinese Golden Pheasants which His Highness introduced in a limited number also did well.

These were the birds which pleased Lord Reading very much as they flew across the rides with their golden tails stretched out, when, as Viceroy, he was the guest of the Maharaja and shot the Karol jungles at Kandaghat, one autumn. The success of the Monals was

however only temporary as, after they got their plumage, they completely disappeared, most probably to the highest hills at Chandni in the hill state of Kahan near Simla. Stray Monals however, as I have mentioned, do still come sometimes to Chail, when there is a heavy fall of snow. Mr. Hutton pointed out to me a place called Chur, only six miles away as the crow flies from the cricket ground at Chail, which is a favourite resort of these pheasants during a heavy winter. The Maharaja once shot in a single day, eighty-five Monal here, in addition to eleven bears.

It was in 1921, on his return from England, where he had done a good deal of shooting with Lord Fisher, that His Highness of Patiala first seriously started introducing English pheasants into India on a large scale. After all his lengthy experiments he had determined upon the Ring-necked Pheasant (*P. torquatus*) as the bird which would survive best in India.

The first thing was to choose a place as a permanent pheasantry, and Kurin, distant about a mile from Chail Palace was selected. A more beautiful and more suitable spot for the purpose, in my opinion, could not possibly have been chosen. In the course of the next five years a small experiment was made with pheasant eggs procured direct from England: they were hatched in incubators by Mr. Goldstein of Simla. Before this the jungles had been prepared for the reception of the birds when they hatched out. The result was that a thousand chicks successfully appeared from these eggs. Unfortunately, only one hundred eventually survived, as the heavy monsoon worked havoc with the young birds. However, experience had been gained and on the whole the experiment had proved successful and the way had been paved for the large experiment to follow.

The Maharaja had been advised by Lord Fisher to engage in England an expert on pheasant rearing and pheasant shooting. A Mr. Max Baker was recommended who consequently arrived in India in the spring of 1926 and immediately came up to Chail and inspected the site chosen for the pheasant coverts. He expressed himself quite satisfied with the jungles chosen, the releasing ground and the rearing field. Everything had been done on English lines, in the way observed by the Mahàraja when he shot in England.

Things being in readiness, an order was given to a pheasant Game Farm in Middlesex, who were asked to send out a game keeper in charge of 400 pheasants—350 hens and 50 cock birds. Under the charge of Cady, a game keeper, the birds were despatched, and from the day of their departure till their arrival in Pinjour—His Highness's game preserves at the foot of the Himalaya—in April 1927, only seven, out of the total 400 died—one cock bird and six hens. One died at sea, and the others found the heat too much for them on the journey up to the north of India from Bombay.

On the arrival of the birds, they immediately began laying eggs—nearly 6,000 all told. Most of these, however, proved unfertile, as on account of the long journey, they had undergone, the hens had become restless and had not mated with the cocks. The failure of the latter to tread the hens was in no way due to bad arrangements in their conveyance. This was all that could be desired. I myself

saw the baskets in which the birds reached India—useful hampers, about 4 feet long by $2\frac{1}{2}$ feet in length, quite sanitary and with side openings for feeding the pheasants.

Three incubators were made use of at Pinjour (Hearson's Hot Water Incubators), and about 200 broody hens. A certain number of chicks were lost, through not being able to get sufficient country fowl in time. The laying was very rapid and the average number of eggs soon went up from 150 to 200 a day. Between May and July about 2,000 chicks, all told, were hatched, and the casualties amounted to round about 200. On July 26 the first batch of young pheasants was conveyed by motor lorries from Pinjour to Chail, a distance of fifty-five miles, and put into the releasing grounds there. They travelled up in the same hampers that they arrived in from England. It had been intended that they should have stayed at the foot of the mountains for at least six weeks more, and it was only the severe heat at the time, that made it imperative that they should be moved to a cooler temperature. The second batch, which I did not see, were due to arrive at Chail on August 10.

The Pheasantry at Chail

The actual Chail pheasantry lies on the mountain side facing the north, that is to say Simla, which is about six miles away as the crow flies, or about thirty-five miles distant by bridle path. A motor road is being prepared to go right up to the pheasantry, which is skirted on all sides by narrow paths to enable one to penetrate into the forestry easily at different places. Rides have been cut from the top of the mountain right down to the bottom of the valley. They are the breadth of the forest and a mile and a half in length. Four had already been completed when I was there. All these rides are intercepted by two roads running parallel along the mountain side. The mountain itself is thickly wooded with pine and oak, except on the southern side which looks towards the lower Himalaya, and is for the most part quite bare. The idea is that the pheasants will be able to go out on this southern slope in the heat of the day and sun themselves. On this side, in the evening, Chukor (*C. chucar*) and Cheer Pheasant (*C. wallichii*) come out on the grass in coveys and broods to feed. During the time I was at Chail, I saw very many birds of both kinds and used nearly always to hear the Chukor and other partridges calling to each other. The habits of the Chukor, I noticed, are different to those of the pheasant, in that they *come up* in the morning to the open places, and *go down* in the evenings, close to the fields.

In the valley below, a stream called the Ashni, which joins another river called the Giri, divides the bare mountains from the thickly wooded jungle on the other side. The Giri is a very fine Mahseer stream and in this place Lord Chelmsford, Lord Lytton, and many another governor and friend of the Maharaja of Patiala, have in times past, enjoyed good fishing.

The country facing the southern slope presents a magnificent panorama, not unlike the peak district of Derbyshire on a huge scale. Except for the villages of Solon and Slogria far away in the

distance, it is a wild and wooded country, which is full of game of all kinds. To anyone who has had the good fortune to have shot in these jungles, reading these lines must revive poignant memories too of happy sporting days gone for ever. Red Jungle-fowl (*G. ferrugineus*), Kalij Pheasant (*G. hamiltonii*), Cheer Pheasant (*C. wallichi*), Chukor or Greek Partridge (*C. chucar*), Goral (*C. goral*), Karkar or Barking Deer (*C. muntjac*), all abound here and the valleys too are full of Woodcock (*Scolopax rusticola*) in the autumn.

As regards the system of Pheasant shooting to be adopted later on, His Highness the Maharaja, who, as I have already mentioned, has done much pheasant shooting himself in England, intends to have no change, but simply to shoot in the ordinary way done at home.

The whole of the jungles are going to be coppiced, as they are rather thick at present. There being no local market for the timber that is being cut, it is intended to run an aerial railway from the Chail forest down to Kandaghat at the bottom of the valley, where the nearest railway station is situated.

I saw, in the first feeding place, in all, about 270 young pheasants. Though only two months old, they looked almost full grown and extremely well and happy. I noticed a couple of albinos among them. In the second pen there were 200, and in the third another 200 birds. It was a pretty sight to see the way they responded to the calls of their keeper at meal time and the manner in which, in the second and third pens, they flew a few yards off the ground in their efforts to reach him quickly.

There are four keepers who feed and look after the foster mothers: the young pheasants will remain with the birds till such time as they are big enough to start roosting on trees Then, in addition to the guards being removed, the coops and broody hens, which are installed there at present, will be taken away, and only the trappers outside the fencing will remain. The birds will then be absolutely alone in the jungles, except when a man comes at certain times to throw grain to them.

Some of the Maharaja of Patiala's Ideas about Game Preservation and His Projected Syndicate Scheme to Prevent Poaching

When going round the pheasant rides, I noticed one fenced all round, which was being used as a releasing ground, and which had Gurkha guards on duty with shot guns to shoot vermin. These men, Mr. Beaty informed me, come under the Game Preservation Department of which he is in charge, and go to form one of its sub-departments. About a hundred guards, or watchers have been organized and it is their duty to prevent poaching and to destroy all vermin by means of the traps and guns which have been given to them.

In the pheasant covert there are always four men on the watch day and night to look out for and kill foxes, and everywhere there are traps laid out and men on the spot guarding the whole area. I

came across a porcupine pad in one of these traps—porcupine are very prolific in these parts of the Himalayas, but of course do no harm to the pheasants.

The Maharaja of Patiala himself takes the greatest possible interest in all this and has personally fixed a reward for every single head of vermin destroyed, whether feathered or ground vermin. Thus for the destruction of a snake, Gohana (Monitor Lizard), mongoose, hawk, (small variety), or a jackal, a reward of four annas is paid: for a hawk, (medium size), pole, civet or wild cat and fox, a reward of eight annas: for a hawk, (large), eagle, pine marten, one rupee is given, while for the destruction of a wolf three rupees, and for an otter five rupees are bestowed.

With all this interest the Maharaja shows in the preservation of game, he has nevertheless much to contend with from poachers; that is why he has organized a special branch of his Game Department solely to deal with them. It is rather sad to remark that offences in this respect are not merely confined to the Indian *ryot*; by far the worst delinquents are Europeans who visit the different cantonments in the hill tracts. It would be invidious to quote specific cases but His Highness personally told me that the offenders are to be found among people of all classes and among people in many cases who ought to know better.

To counteract all this poaching the Maharaja has thought about the possibility of starting a scheme which he has conceived, whereby certain areas of his territory will be leased to a syndicate. Such a mode of procedure, while most magnanimous, however, might, I think, reduce the game in the surrounding area, because of excessive permits being granted by the syndicate.

The Pheasantry of the Maharaja of Patiala in the Pinjour Moghul Gardens in the Foot-hills of the Himalayas

I was immensely impressed by all I saw at Chail in connection with the pheasants and by the condition of the young birds, and in conversation told the Maharaja this, and expressed the opinion to him that everything augured well for the successful realization of his plans. He told me that, if all continued to prosper, he intended to have a small trial shoot towards the end of the year. His Highness then asked me if I would care to go to see the place where he first had the pheasants put down when they arrived from England. They were installed in the grounds of a beautiful old Indian garden-palace built for the hot weather, situated far down in the Himalayan foot-hills country. The place is called Pinjour and in the vicinity of the Moghul gardens are very fine game reserves.

I very readily accepted the Maharaja's kind invitation and on August 10, in company with Sahibzada Abdul Munim Khan, A. D. C. to His Highness and Mr. Hutton, we set out by motor for Pinjour. Leaving Chail in the forenoon, we descended the narrow road which winds round and round the mountains for eighteen miles to Kandaghat. Only one car can descend at a time and the road is kept clear by means of telephonic communication. On my way up

some days before, upon turning round a corner rather suddenly, I encountered some camels and very nearly collided with the animals: they appeared very much alarmed. Little could be seen of the magnificent scenery and the beautiful wooded country, as it was raining hard and the valleys were wreathed in mists.

The rains made the roads very slippery and, as there was considerable danger of going over the *khud*, we had to proceed very slowly. Few accidents have occurred however: the last took place a few years ago, when a car returning from Simla late in the evening, bringing back a doctor, swerved and went over the precipice. The doctor, who was seated on the opposite side to the driver, managed to slip out, but the poor chauffeur met his end. I saw the place where the accident happened: it is now marked by a black cross on the edge of the ravine bearing on it the ominous inscription 'REMEMBER SONA SINGH.'

At the time of the year—the monsoon,—when we traversed the road, there is always danger from the frequent land-slides and falls of huge boulders. We encountered many on the way, but were not stopped, and about nightfall reached Kalka, quite near to which is Pinjour, the place chosen by His Highness of Patiala for resting the first pheasants he had had brought over from England.

* * * * *

On the morning of August 11, I was awakened by the cries of peafowl and the 'Ha, Ha, Ha. r. r. r. . . .' of the keepers of the young pheasants frightening away crows and hawks. From the roof of my room I got a magnificent view—the Himalayas rising sheer upwards to the east: to the west, a circle of low hills and southward the plains. Down below were the entrancing wooded gardens, whose vistas were no longer dim, as on the previous night, but along whose shallow terraces fountains were playing and water was falling in smooth sheets. Everywhere on the grass were arranged in symmetrical lines the pheasant coops, and on their account the garden presented a somewhat wild and neglected appearance—an illustration of the lines written hundreds of years ago:—

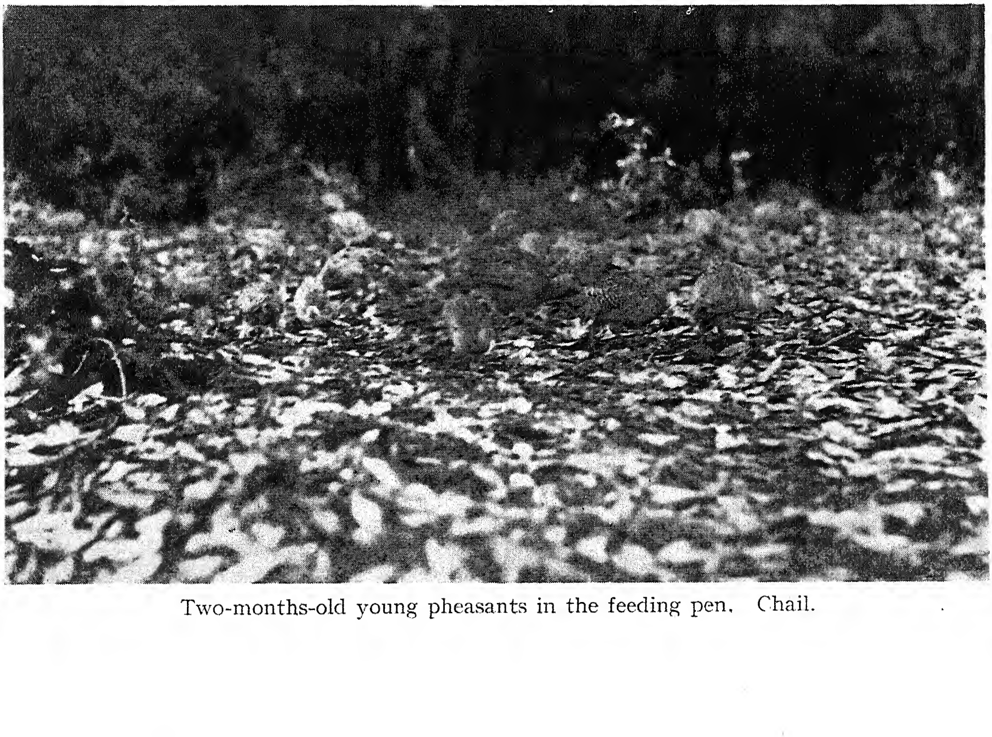
> 'Gardens of old, nor art nor rules obey'd,
> But unadorn'd, a wild neglect betray'd.'

Later, I went round the Pinjour pheasantry with Cady the gamekeeper, who resided there. I thought the selection of the gardens, as a place for the commencement of his pheasant experiment a very happy thought on the part of the Maharaja of Patiala. One thing that immediately struck me was the utility of the high wall surrounded with battlements, which completely circumvented the whole garden. It prevented all molestation of the pheasants by the larger species of vermin.

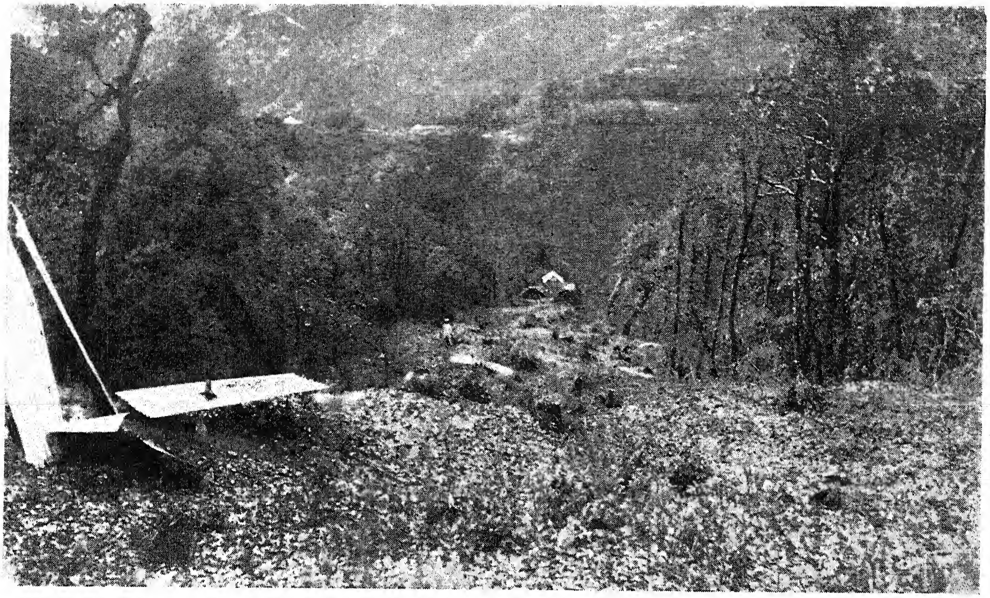
Cady gave me the history of the young birds under his charge since they left England early in the new year. It appears that he had had no difficulty with them and they seemed to be standing the journey very well until they reached the Red Sea. It was then that he experienced some anxiety as the extreme heat began to

PINJOUR GARDENS.

Pheasant coops arranged in symmetrical lines in the glorious wooded *bagh*.



Two-months-old young pheasants in the feeding pen. Chail.



A ride in the jungles, used temporarily as a releasing ground for pheasants.

Cut jungles ready for the reception of pheasants.

make the young pheasants gasp very much. Permission was thereupon obtained from the Captain to put a tarpaulin and a cricket net over the hatchway which, besides creating a shade, prevented the pheasants from getting away and flying out to sea. Cady then of course spoke about the loss of birds mentioned before. This was only to be expected, considering the heat of India and the long journey up-country from Bombay. On March 5, the pheasants were turned down in the pens at Pinjour. Each wire pen had in it about 120 hens and 20 cocks and they seemed to be very happy. Cady told me that the first egg appeared on April 5. His diary showed that on the 6th three were laid: on the 7th six, and they gradually went up in increasing ratio till they reached the maximum of 209 a day.

In the middle of April myriads of locusts arrived and settled down in the country close to Pinjour. They ravaged the district and greedily devoured everything there was in the way of vegetation. I myself saw the effects of their devastations on the trees round about, especially the palms. Many of these, even now, were only just beginning to recover from the ravages of this terror. Strange to say the locusts coming had a great effect for the better on the young pheasants.

Towards the end of May the eggs of the locusts produced young ones. These began to crawl about and ascend the mountains. An idea of the vast numbers of these swarms can be gauged from the fact that they became so thick on the lines of the Kalka-Simla Railway, that a train was detained, and the driver and the guard had to send for a railway gang to turn out and clear the insects off the lines before they could move and continue their journey.

The young locusts continued their crawling right up to Pinjour and upon their arrival there, Mr. Beaty turned out hundreds of men, who were detailed off to try and prevent them from going into the pheasant pens. Inspite of everything nothing could stop them on their onward march. The next thing that happened was most remarkable. The young pheasants began to eagerly feed on the locusts, and to stop eating their corn, and in fact during the rest of the time Pinjour was visited by the plague of these insects, no more grain was given to them—that is to say for a whole month. They ate the locusts voraciously and in a correspondingly amazing way, laid eggs. The only detrimental thing about it all was that the broody hens were very much disturbed, as all the sitting boxes were full of these insects. This caused many eggs to go bad.

The Maharaja of Patiala's pheasant experiment, we may safely assert, has established one interesting fact, namely that a locust diet is to be recommended to make pheasants in India lay freely.

Out of the first batch of pheasant eggs put down under broody hens at Pinjour, the net result was 270 birds hatched out. More should have appeared: the reason they did not was, that the extreme heat of the ground and the rays of the sun started incubation immediately the eggs were laid. In the early hours of the morning, the air and ground cooled and the life in the eggs became cold, to the detriment of the potential chicks. It is only by experiment that one really finds out things. Such a difficulty would never have

occurred in England in breeding pheasants, but in an experiment in India, even with such a fine climate as in Chail in the Simla Hills, unexpected difficulties and unthought of results may crop up at any time. What has been said about the reason for more chicks not being hatched out is not a theory. Cady gave me positive proof for what has been asserted.

A fertilized egg, which was put in an incubator on May 18, hatched out on June 6,—that is to say it took nineteen days, instead of the usual twenty-four. Two more eggs hatched on June 7 (i.e. twenty days), and two more on June 9th (i.e. twenty-two days).

The remainder of the birds hatched out on the proper dates. The young pheasants grew excessively fast and after they were three days old, 'could' in Cady's own words 'fly like quail'.

There were very few casualities from ordinary causes, such as weakness, and being trodden on by other birds. Out of the first 270 only ten succumbed. There was not a single case of cramp or gapes, illnesses which at home are such common causes of disaster to young growing pheasants. Nor was there any serious loss through sickness.

Very few chicks were ever missed as a result of being seized by the numerous birds of prey in the vicinity. The pens had plenty of men on the look out with guns, and these precautions invariably met with success. Hazara Singh, the Assistant Game Preservation Officer, on one morning alone, shot sixty hawks. He told me of a curious thing that happened one day in this connection. A shikari brought in a live hawk in his arms. The bird of prey had dug its talons into the back of a young pheasant; it had then been unable to disengage its claws and had thus been captured alive. The young pheasant of course succumbed to its wounds.

No further hatching is to be done at Pinjour, as experience has taught that the atmosphere there is too hot. It has therefore been decided to have two hatcheries in the future, one at Kandaghat and one at Chail, so that if an epidemic breaks out in one of these places, the birds in the second place, will not be affected. I saw the proposed site of the one at Kandaghat—a splendid place on the hillside with the Ashni River bordered by stretches of grey-white sand, winding along below. Here in this poultry farm all the birds used will be English, so as to be able to have brood hens for the pheasantry. There will always be 600 as stock birds which will be changed every autumn. In order to prevent the stamina deteriorating, alternately cock and hen birds are to be procured from England.

Pinjour Jungle Game Reserves

After breakfast on the morning of August 11, I rode out with Mr. Hutton, Hazara Singh and a band of shikaris, to view the Patiala game preserves, which lie about three miles from Pinjour gardens. The Siwalik Range, which is separate from the Himalaya, and on which lies Dehra Dun, rises above them. These low hills present rather a reddish appearance as looked at from a distance.

The rain was coming down very hard, but we managed to cross the Kausalya River, which was very much swollen, and about a

quarter of a mile broad. In parts we went up to our waists. In ordinary circumstances, it would have been possible to have taken a car with us and to have motored along the roads and magnificent rides in the jungles. Other rulers have copied this excellent method of cutting rides throughout the forests. His Highness of Patiala, as in many of his plans, adopted this after shooting in England and Scotland. I remember when I visited Patiala for the first time on the occasion of the Prince of Wales' visit there, remarking on the fine rides in the jungles at Bunerhari, Sanaur and Bahadurgarh.

After crossing the river, Hazara Singh took me right into the jungles and we galloped about on horseback most of the day inspite of the rain. We observed the movements of much game, such as deer, sounders of pig, peafowl, partridge, pheasants, etc., but would of course have seen more, and I would have been able to take some excellent photographs, if it had been fine.

The forests hold Goral or Hill Goat (*C. goral*), Barking Deer (*C. muntjac*), the Indian Wild Pig (*Sus cristatus*), Bear (*U. torquatus*), Panther (*F. pardus*), Nilgai (*Boselaphus tragocamelus*), Chital (*C. axis*) and Sambar (*C. unicolor*), Jungle Fowl (*G. ferrugineus*), Peafowl, (*P. cristatus*), Partridges (*A. torqueola millardi* and *F. francolinus interpositus*), green pigeons, pheasants and quail. Sometimes Tigers and Lynxes (*F. lynx*) are met with. The Maharaja told me that in 1925, when Lord Winterton and a party shot these jungles, he saw two of the latter animals in a beat, but they were not fired at as they are getting very rare in those jungles.

In the evening I went up a fine stone *machan*, which commanded a view of the two river beds full of silt, and also towered over no less than five jungle rides. It was a striking sight to watch the movements of game, especially the great herds of Chital feeding on all sides, quite unconscious of our presence. They always, I noticed, had sentinels on the outskirts of the rides, who were very much on the *qui vive.*

A thing that impressed me very much about these jungles was the excellence of the *machans.* They all had numbers and were most massive and comfortable. Situated high up in the trees, they commanded fine views, with plenty of space to swing round in every direction in order to get a good shot. They were all painted green to correspond with the foliage of the trees.

Chital are the most numerous animals here. The Nawab Sahib, His Highness's A.D.C., told me that on one occasion, when he was with the Maharaja and the jungles were being beaten—in these parts they do it with a long sweep all round the rides—he counted over 300 Chital pass under the *machan*, a hundred of which were stags, six having exceptional heads. 'His Highness would not shoot any of these pretty deer, as he did not consider it sport,' said the Nawab.

When one sees these beautiful animals in the jungles and their pretty ways, one has no desire to shoot. To watch them with glasses, take notes, film them, yes. But why shoot animals, which are not dangerous, when there is no necessity to do so, and deprive them of the existence they are entitled to? The Game Warden of Kenya, when he stayed with the Maharaja of Patiala last year expressed the same views, and neither wished nor

attempted to shoot, but derived all his pleasure from just sitting and watching the jungle animals and their interesting habits. He had a true love of nature and was no ruthless slaughterer.[1] It has been rightly said that the real charm of natural history must be in the mind of the person who seeks information at the hands of nature: and no words can describe the never-ceasing, ever-varying delight that such a mind is susceptible of, when able to appreciate the wonderful works of the Creator as seen in his creatures and flowers and trees.

This day in the jungles, we only visited the Chital block. It was not possible to enter the Sambar blocks at this time of the year as an intervening river dividing the forests was abnormally swollen and impassable.

The return journey back to Pinjour gardens was fraught with a certain amount of danger. A very bedraggled and wet-to-the-skin party of horsemen, we must have appeared, as we reached the Kausalya River about six o'clock in the evening,—the river we had successfully forded in the early morning. We stood and gazed with dismay written all over our faces at what lay before us— the heavy and continuous rainfall had changed the morning's rapid running stream into a perfect raging torrent. It looked as though we were in for a wet night in the jungles.

However His Highness's head shikari, a very brave man, named Gooria Singh, without hesitation, volunteered to take me across. With a long stick, like an alpine stock, he went on ahead, and I followed him slowly on horseback. It was a most exciting experience as often we were up to the horse's head in water, and repeatedly one felt oneself whirled round with the force of the current. It took half an hour before we found ourselves safely on the far bank of the river. The brave shikari then went back for the rest of the party. An incident occurred in which one of the under-shikaris was very nearly drowned. The horse which he was riding, was caught by the stream, and from the distance I could see it gallantly rising on its hind legs as it was borne down by the violent rushing water. Then suddenly it went under the water and both horse and rider disappeared. As the seconds went by and we saw nothing of them, we feared the worst. The man could swim however, and after about a minute had elapsed, he was seen scrambling up the bank several hundred yards further down the river. The horse too, managed to rescue itself and the only things which really suffered were the saddle and my *topi*, which the shikari happened to be carrying at the time—a very wet sodden thing, and of no further use whatever after the day's rain. The man was much more perturbed about the loss of the latter article, than by the extremely alarming experience just enacted in which he had taken the chief

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[1] I believe I am right in stating that during Mr. Dunbar Brander's last years in India, he never shot a single animal, not excepting Tiger, but was content to observe and note their habits. Hence his wonderful book *Wild Animals in Central India*. *Vide* also Mr. F. W. Champion's recent enthralling book *With a Camera in Tiger-Land*. True naturalists both of them.

part. When I called him to me later on, he was very much frightened and completely astonished and non-plussed when I presented him with a little largesse. He had expected a beating.

We slept a very sound sleep at Pinjour that night and early the next morning started on our journey back to Chail.

Near Kalka, Mr. Hutton pointed out to me a spot, practically in a village, where once, when he was motoring, he had seen a panther seize a dog in broad day light. He happened to be motoring up from Patiala at the time, but had not a rifle handy. In connection with panthers, the Maharaja of Patiala told me, that once at night time on the circular road which runs round Chail, he saw a panther sitting on a tree and promptly shot it. A pair were caught nearby last year by tying goats in a cage. All about Chail panthers are very numerous. I used to hear their loud sawing bark resounding throughout the valleys every evening.

The Maharaja of Patiala's Experiments in introducing Red Deer, Merino Sheep and Australian Hares into India

In addition to importing non-indigenous birds into his territories, His Highness of Patiala has also turned his attention to mammals in this direction. As the scene of these experiments was near Kandaghat, which we were passing in the car, I stopped there, and on horseback, accompanied by the forest rangers, ascended the mountain by a very narrow and tortuous bridle path. It was very thickly wooded in most parts, and the places which were barren, had an extensive growth of grass. The whole mountain scenery was not unlike the highlands of Scotland.

Half-way up the mountain-side were large wire fencements and inside these the Merino sheep were herded. I saw about thirty—mostly rams. They have not been there very long and have not become quite acclimatized, and seemed, I thought, to be feeling the damp monsoon weather very much. Personally, I considered, it would have been better, if they had been dispersed to different farmers immediately, and not huddled together here, as they did not seem very happy and some of them seemed to be rheumatically inclined. His Highness's idea in introducing these sheep from Australia, is to present each village in his territories with a ram and thus improve the stock of sheep in Patiala. Later he intends to do exactly the same with milch cattle.

At the top of the mountain, at a place called Karol, about 7,000 feet high, a big area had been fenced in and Red Deer put down. It was a splendid place and commanded magnificent views of Solon, Simla and Chail. The Maharaja has purchased from Scotland eighty head of Red Deer all told—70 hinds and ten stags. He started off with thirty in 1926 and the rest were brought later. The first batch when they arrived, were kept for some time in one of the parks near the Palace in Patiala. They were then brought to Kandaghat and put in the fenced enclosure and fed there till they had got used to the jungles and completed their horns; afterwards they were gradually given their freedom. The second batch came direct from England

to the mountains of Kandaghat, where the same method was carried out with them.

Of the Red Deer I saw—they were driven towards me in a great drive by the rangers and shikaris—does and fawns were the only ones that came out. They all looked very well and quite tame and allowed me to get within 20 yards of them. My not seeing any stags was not at all unusual as, in accordance with their habits, they are seldom seen at the time of the year when I was at Karol. The fences, the gates of which were all open, were in process of being removed, as they are not necessary, the deer having thriven so well. In 1926 five calved, and nine fawns have been seen this year in the jungles but it is believed that practically every hind has had young. This preliminary deer experiment having been so successful, it is intended to expand it throughout the Patiala jungles in the hill tracts. The only casualties there have been are, two killed by panthers and two killed by fighting among themselves. One stag was shot by a poacher and His Highness told me that he is 'hot on his track'.

Four or five antlers of Red Deer have been picked up, but probably more have been shed and kept by villagers who use them for medicine.

The introduction of Australian hares has also been effected in Patiala territory. The reason why it was started was on account of a great flood which took place in the State in 1924, when practically every hare next to the reserve area was drowned. To try to replace them, an attempt was made to get 100 out from Australia as an experiment. Unfortunately this first experiment was not a success and only ONE of these rodents reached England, out of the first consignment and it died immediately on arrival at the port of Bombay. However this disaster was only due to the fact that the hares were despatched at the wrong time of the year and was soon remedied, and now they are arriving in Patiala at the rate of 100 a fortnight.

It being such a fine afternoon, I preferred to ride the 18 miles upto Chail on horseback, rather than go by car. In this way I enjoyed to the full the exhilarating Alpine scenery and observed the beautifully green valleys down below which are full of Chukor and other game. As evening came on, as usual, I could hear both these birds and also the black partridge calling. After keeping to the road for ten miles, I branched off by a bridle path through the forests and here disturbed many a pheasant looking about for its evening meal. The Deputy Commissioner of Simla, Mr. Salisbury, who walked up this path two days before, told me that he saw several Pine Marten (*M. abietum*) on the way. They are very common in Chail. The Maharaja said that on a shoot at Pinjour with Lord Dudley, a year or two ago, he shot one which came out in a beat.

Thus ended a very pleasant visit to Chail; the memories of which and the true hospitality shown me by my princely host will always remain with me.

In regard to His Highness's game experiments, he has, in my opinion, only touched the fringe of what he will accomplish in the

future. He is most far-seeing in all these matters and possesses all the true qualities of the naturalist. I trust and hope that he may long be spared to carry on his great game schemes. I consider that the auguries for the future of His Highness's game department are most auspicious.

In concluding this article, I would like to add that the Maharaja of Patiala told me that he would gladly welcome advice, suggestions or help in connection with big and small game preservation and experiments from any naturalists or sportsmen of repute. Any correspondence on these matters should be sent, in the first instance, to the Game Preservation Officer, Patiala State, Punjab.

THE MIGRATION OF THE PIED CRESTED CUCKOO (*CLAMATOR JACOBINUS*)

BY

HUGH WHISTLER, F.L.S., F.Z.S., M.B.O.U.

(*With a map*)

It has long seemed to me discreditable to all of us who work at Indian Ornithology that we have made no serious endeavour to work out the migrations of so conspicuous and easily recognized a bird as the Pied Crested Cuckoo. The words 'a rains visitor' run like a refrain through all accounts of the species, but I have never seen any attempt to show where it goes to or comes from at other seasons of the year, and this is given as its status in so large an area of India that one is tempted to wonder where it can possibly live for the remainder of the year as it is not found to the east or south of India save in a small area in Burma and in Ceylon. It is however found in a considerable part of Africa, and I have often wondered whether this Cuckoo can be amongst that small company of species that winter in Africa after summering in India.

In hopes of throwing light on the question I have recently devoted some time to collecting and collating records of the occurrence of the Pied Crested Cuckoo The results of this collection have been disappointing but it is perhaps worth laying them in front of the readers of our Journal in the hopes of persuading them to assist in throwing light on the question.

I start with the north-west corner of India and proceed to relate what I can find on the subject.

In the N. W. F. Province the bird is very scarce.

That careful observer Whitehead, in his survey of *the Birds of Kohat* (*Ibis*, 1909. 254) says that it occurs rarely during the autumn migration and that he met with it on three occasions, in August and September.

Briggs never met with it at Peshawar in the five years that he was there.

In the Northern Punjab it is not uncommon, and gradually grows more numerous as one approaches the east and south of the province. Of this there is plenty of evidence and it is clear that in the province it is a rains visitor arriving for the purpose of breeding. To detail the evidence:—

At Rawalpindi I saw a pair in the Topi Rakh on July 9, 1911. Mr. B. B. Osmaston obtained a specimen at Rawalpindi on November 3, 1924; this is a young male of the year and may be considered as a lost straggler as there is no other winter record for the province known to me.

Briggs saw a single bird on August 1, 1925 about ten miles out of Rawalpindi on the Murree Road.

It is commoner in the Jhelum District both in the plains and plateau and in the Salt Range. In 1913 I met with about six individuals in the district between June 15 and September 4.

Theobald says (*N. and E.* ii. 388) that at Pind Dadan Khan and Katas it lays in August. Mr. H. W. Waite reports that it turns up pretty regularly in July and August in the Jhelum Salt Range and that in 1926 he saw several of them at the end of June and took an egg from a nest of *Argya caudata* on June 29 at Sethi 2,600 ft. He also reports that it is fairly common at Sargodha in the rains.

South of this area it is common in Jhang District, arriving at the beginning of June and leaving by the middle of September ; during its stay it breeds in the district (Ibis. 1922, 405). Somewhere below Jhang there is possibly a gap in its distribution as indicated under the head of Sind, but its apparent absence is probably due to a dearth of observers.

In the Central Punjab the bird is very common. At Gujranwala (*J. B. N. H. S.*, xxiv, 701) in 1915 I found that they arrived in the first half of June and for the first week or two were very noisy and conspicuous while courtship was in progress. After breeding they started to leave again early in August and had practically all gone by the end of the month.

Dewar implies (*J. B. N. H. S.*, xviii) that at Lahore it is only a passage migrant as he says that it appears ' for a few days in July and August', but Currie (*J. B. N. H. S.*, xxiv, 570) states that it is found there from June to September and makes it clear that it breeds during that period. He saw a young bird still with its foster-parents as late as October 16 (loc. cit. xxiv, 595). I have a note from Mrs. Wathen of two young still with the foster-parents on October 14 (1921) at Amritsar. At this station Meinertzhagen found it throughout June.

At Ludhiana in 1917 I did not meet with the Pied Crested Cuckoo in June but saw it first on July 1. It was very common and noisy throughout July and August, and about the middle of September it began to grow scarce, though a few stragglers were noted until October 3 (*J. B. N. H. S.*, xxvi, 592).

In Ambala district Mr. A. E. Jones notes (*J.B.N.H.S.* xxxi. 1005) that it is widely and commonly distributed in July. Cordeaux (*Ibis*, 1888, 224) also says that it is very common at Ambala in the hot weather.

At Hissar it is very common in the rains. In 1914 I saw the first on June 6, but it was not common till July ; from July to the middle of the September it was plentiful and a few were noted until October 1.

In Rohtak District Mr. A. H. Marshall tells me it occurs in the rains though he did not find it common.

At Delhi I have heard it on July 1 and 2, when I was passing through. A September specimen from Gurgaon near Delhi is in the Hume collection.

So much for the Punjab proper ; its status in the Punjab Himalayas and contiguous areas remains to be recorded.

I find no record north-west of Gilgit where on June 15, Biddulph

procured a female, 'apparently breeding' which had been killed by a native (*S.F.* ix, 315). This is now in the British Museum.

In Kashmir it occurs regularly but sparingly as a summer visitor. According to B. B. Osmaston (*J. B. N. H. S.* xxxii, 140) it frequents the lower bush-covered slopes of the hills near Srinagar between 5,000 ft. and 6,500 ft. Ward had a specimen dated May 29, and had seen others in the valley as for instance at Martand (*J.B.N.H.S.* xvii, 108). Lawrence says the call is heard most commonly at the beginning of the rains in July (*Valley of Kashmir*, 1895). Abbot obtained specimens both adult and immature in the vale of Kashmir between August 12, and September 1, 1891 (*Proc. U. S. Nat. Mus.*, xviii, 451). Cordeaux obtained a specimen at Verenag on June 15, 1887 (*Ibis*, 1888, 224).

Currie records that he once heard it at night at Murree in the hot weather (*J.B.N.H.S*, xiv, 595), and I myself saw it at Kothi (5,000 ft.) near Murree on May 27, 1911. Two undated specimens obtained at Murree by Biddulph and Col. Way are in the British Museum.

Along the Kangra Valley and in the Mandi State up to about 5,000 ft., it is a fairly common rains visitor, arriving in June and remaining until September. I saw a single bird at Chakki on October 9, 1921 (*Ibis*, 1926, 750).

In Kulu the Pied Crested Cuckoo is not uncommon in June and July in the Lower Beas valley round about Bajaura (*J.B.N.H.S.* xxxi, 477) and I have heard it also at Banjar, 5,500 ft. in Saraj. On June 28, M. Babault obtained a male with the organs in breeding condition at the upper edge of the forests at 12,500 ft. at Rahla by the Rhotang Pass (*J.B.N.H.S.* xxxi, 477.) Stoliczka (*Ibis*, 1868, 320) met it at Serahan 9,000 ft.—10,000 ft. and Urni 6,000 ft.

In the Simla Hills, Jones states (*J.B.N.H.S.* xxvi, 615) that it is very common in the cultivated areas up to 5,500 ft. and occasionally found up to 8,000 ft.

He gives no dates but Beavan obtained specimens at Simla in July and September 1866 (*Ibis*, 1869) and there are three July specimens from Simla in the Hume collection as well as a pair from Fagoo, dated July 29, 1868. On the Simla-Mussoorie Road in June 1867 Tytler saw several after leaving Thaena in the valley of the Jumna (*Ibis*, 1868. 202). Meinertzhagen saw it at Chakrata on May 17 and June 11. At Dehra Dun according to Thompson (*N. and E.* 2nd ed., ii, 388) it is very common and lays in July and August and he adds that he has seen it in Gurhwal during the breeding season though it is not common there. Two adults from Naini Tal (September) and one from Almora (August 13), are in the Hume collection. Brooks saw it a few times at Almora (April to June 1868, *Ibis* 1869, 47).

In British Baluchistan the Pied Crested Cuckoo apparently does not occur. In parts of Sind however it is common and here also as in the Punjab as a rains visitor. Ticehurst's account (*Ibis*, 1923. 39) is explicit as follows, and it absolves me from recounting earlier records in the province. 'A visitor in the rainy season and not uncommon. It arrives at Karachi about the beginning of June (earliest date May 29) and I think must leave again in September. I once

saw quite a number in some desert jungle near Karachi on September 16, where I know they did not breed, and these were evidently working their way south . . . . a few may still be met with in October, the last was seen on October 30. Barnes found eggs at Hyderabad on August 20, in nests of *Argya caudata*, and Doig thought it bred in June and July in the East Narra District where it is common. From Upper Sind there are no records, nor does it so far as I know occur west of Karachi.'

In Cutch, Kathiawar, Gujerat and Mt. Abu, Butler tells us that it is a ' seasonal visitant, only occurring in the rains, at which season it is tolerably common ' (*Bombay Gazetteer*). Elsewhere (*S. F.*, iii, 461) he says in more detail about Mt. Abu and Northern Gujarat that it is ' very common both on the hills and in the plains, arriving just before the monsoon. It lays freely in July during which month in the neighbourhood of Deesa I have seen a great number of the eggs.' Later (*S.F.*, v. 227) he says again of Deesa that it occurs only in the breeding season and he gives the dates of arrival and departure as May 25, and October 20. There is an adult male in the Hume collection from Anandra near Mt. Abu dated July 5. A specimen from Kathiawar, evidently collected at Rajkote, cf. *Ibis*, 1873, 407, shot by Col. Hayes Lloyd on June 11, is also in the British Museum.

In the desert region of Rajputana it appears to be rare or wanting or more dependent on the state of the rainfall, for I only find that it was obtained by Adam at the Sambhur Lake. In *Stray Feathers*, i, 372, he says of it ' very rare, obtained in July ' but there are however two of his birds in the British Museum dated August and September respectively.

I now pick up the thread where we left it at the boundary of the Punjab and the United Provinces, and pursue it southwards from there returning afterwards to deal with Bihar and Bengal.

Of the United Provinces as a whole Gill says (*J.B.N.H.S.*, xxx, 282) ' makes its appearance with the advent of the monsoon ; breeds from about July to September.' This is supported by several local records.

There are three birds in the British Museum collected by A. Anderson in Futehgarh District in July and August, as well as a bird from Etawah.

At Agra Adam found newly-fledged young being fed by the Large Grey Babbler on August 13, (*N. and* E., ii., 388). At Lucknow, it is true, Reid declared it to be 'fairly abundant at all seasons' (*S.F.*, x., 27), but Jesse corrected this by the statement that it does not appear till the beginning of June after the rains have commenced and that he had never seen it after September, except for a single bird in November 1901 (*Ibis*, 1897, 556 and 1903, 58). At Gonda, Field says it is common in the rains (*J.B.N.H.S.*, xxviii, 762). It is common all over Gorakhpur District according to A. E. Osmaston (*J.B.N.H. S.*, xxii, 541), but he says nothing of its status.

Major Hingston informs me that at Fyzabad it arrives at the beginning of the rains, first noted in 1921 on June 14, and that it was common until at least July 19. There is in the British Museum a juvenile male obtained by A. Anderson at Goorsehingunge,

just below Fyzabad on August 11, 1876. Two birds, also in the British Museum, collected by Brooks at Moghulserai are however dated November and January. The Hume collection contains an egg collected at Allahabad on July 28. In the British Museum there is an adult bird killed at Jhansi in August and eggs taken there on June 28, (Blewitt), July 18, and in August (Blewitt).

With reference to Central India, especially round Mhow and Neemuch, Swinhoe and Barnes (*Ibis*, 1885, 63) say that the Pied Crested Cuckoo is 'very common after and during the rains. It breeds throughout the monsoon quite up to the end of October, depositing its eggs in the nests of *C. caudata*.' An adult male collected by Col. Swinhoe at Mhow on October 6, is in the British Museum.

At Mhow in 1927 Rev. F. S. Briggs writes to me that he observed it as follows: July 29, a single bird; September 21, a pair at Jeshwantnagar twelve miles S.W. of Mhow; September 30, a juvenile bird; October 7, a single bird.

At Sehore, Whitehead (*J.B.N.H.S.* xxi. 162) says it is abundant during the monsoon and he gives the dates of arrival and departure as June 5, and October 13. For the Central Provinces I find the following records. At Saugor and Damoh, Moss King (*J.B.N.H.S.* xxi, 97) includes it in his account of the resident birds as common, but I do not think he is using the term resident in its technical sense. The Hume collection at any rate contains an adult female and a juvenile collected at Saugor in July. There is also in the British Museum an egg taken by J. A. Kemp at Jubbulpore on July 2.

One was seen at Pachmarhi near Foxrock on July 14, by Capt. R. S. P. Bates (*J.B.N.H.S.*, xxx, 918).

To continue down the western side of the Peninsula. Barnes records that an egg was taken at Baroda by Capt. Sadler. Davidson is very explicit about Western Khandesh: 'arrives early in June, 4 he says, 'is very common in all the scrub jungles round Dhulia,' laying in the nests of *A. malcolmi* and *C. caudata* . . . it leaves about September' (*S.F.*, x, 299). Two of his specimens dated June and July are in the British Museum.

At Bombay and in the surrounding district, says Kinnear (*J.B.N.H.S.*, xx, 537) there is every year a large influx about the first week in June, while the birds depart after the rains. I personally saw one in 1925 near Bombay on October, 5 and Swinhoe saw one there between November 10–14, 1863 (*Ibis*, 1864, 416). Fairbank records it without comment at Ahmednagar but two immature males obtained by him there in October and November are in the Tweeddale collection in the British Museum. There is also a November specimen from Matheran in the Hume collection.

Meinertzhagen saw it at Poona on September 2, and a specimen collected there by Capt. P. H. G. Gosse, on August 15, 1918, is in the British Museum. Fairbank records it without comment from Mahableshwar (*S.F.*, iv, 255). In his paper on the South Konkan (*S.F.*, ix, 55) Vidal says, 'Devrukh, rare. Has been seen also at Daputi and on the summit of the Amba ghat in the Kolapur District.'

Here we appear to reach the southern limit of the Pied Crested

Cuckoo as a common rains visitor. For while Davidson and Wenden (*S.F.*, viii, 79) say it is common in the rains and believed to breed in the Deccan, i.e. in the valley of the Bhima, Butler elaborates the position as follows (*S.F.*, ix, 388) :—

Deccan and South Mahratta country. 'Seasonal visitant. Occurs I believe only in the rains. Generally distributed throughout the region, but much more common in the north than in the south. In fact in many of the southern districts, for instance Ratnagiri, Belgaum, etc., it only occurs as a straggler.' One of Butler's birds from Belgaum, dated August 25 is in the British Museum.

Yet Macgregor on the other hand says (*S.F.*, x, 437) that in Belgaum District it is 'very common at all times of the year, frequenting low thick jungle whenever it occurs north of the Malprabha River.'

I will now return to North-east India and trace the bird's status down the eastern side, before dealing with its apparently somewhat different status in Southern India.

To deal with Bengal first. In that province Jerdon says it is only at all common in the rains (*B.I.*, i, 340) and Hume says (*N. and E.*, ii, 388) that its breeding season in Bengal is the same as in the Punjab and United Provinces, i.e., latter half of June, July and August. It breeds at Darbhanga in June (*J.B.N.H S.*, xvii, 50 and 893). In Jalpaiguri District, Inglis says it is common in the plains from April to November (*J.B.N.H.S.*, xxvi, 999). In Sikkim it does not occur which makes all the more curious the capture of a single specimen (♂) on June 20, 1921 at Tingri, 74,000 ft. by the first Mount Everest Expedition (*Ibis*, 1922, 504). This skin is in the British Museum but the label bears the date June 30.

At Fareedpore, Cripps says (*S. F.* vii,265) it is very common during the rains, at the close of which it leaves the district; he saw the first bird on May 15. At Dacca it is 'very conspicuous at the end of the rain's (Simson, *Ibis*, 1882, 87), In the Calcutta District, with special reference to Titaghur on the Hooghly twelve miles north of Calcutta Munn says (*Ibis*, 1894, 55) that it is 'common and generally distributed, but only during the rainy season—the earliest arrival I have noted was on May 18, 1890—and leaving again after the rains, at the end of September. They commonly deposit their eggs in the nests of *C. canorus*.' Beavan procured a solitary specimen at Barrackpore on September 28, 1864 (*Ibis*, i 1865, 413). A specimen in the British Museum from Calcutta is however dated January.

Ball says it occurs in Chota Nagpur, but very rarely : he saw one in the eastern part of Manbhum, and he also shot it at Birbhum. Lohardugga he gives as another locality (*S. F.*, ii, 394). A. McLevin however seems to have found it more common in Palamow (*S. F.*, iii, 290).

In Assam it appears to be by no means general. Stevens only observed it once in North Assam, an immature bird found in Dejoo, North Lakhimpore on September 25, 1910 (*J. B. N. H. S.*, xxiii, 558). Hume had no record of it from the Valley of Assam though he received it from N. E. Cachar (where Inglis says he only met it once, in May 1876, *S. F.*, v, 27) and from Shillong, where Godwin-Austen says (*J. A. S. B.*, 1874, 155) it is common in June. In the

Khasia Hills it is common according to Stuart Baker (*J. B. N. H. S.*, xvii, 4) and the Tweeddale collection contains an adult male, dated August from Siong in that area. Stuart Baker records that he shot one of these cuckoos on May 15, 1892 at Gunjong, N. Cachar, from the nest of *Alcippe nepalensis* in which it had laid an egg (*J. B. N. H. S.*, xvii, 50).

In Manipur, Hume considered it rare and adds, 'I saw it perhaps five or six times in the basin and shot two, but I never observed it in any part of the hills (*S. F.*, xi, 76). One of the specimens dated May 23 is in the British Museum.

With Burma we meet the easternmost boundary of the Pied Crested Cuckoo. In Upper Pegu it is common. Jerdon says (*B. I.*, i, 340) that it is more abundant there than anywhere else he has observed it. Oates says it is common in the scrub-jungle round Thayetmyo and as far south as Prome and Engmah, while he has traced it to the foot of the Pegu Hills on the east (*Birds of B. Bumah*, ii, 118). Unfortunately neither of these authors hint at the bird's status in Burma, an unfortunate omission from the point of view of my enquiry. The British Museum collection however reveals that Wardlaw-Ramsay collected an adult male and two females at Thayetmyo in September and that Oates obtained an adult male and female at Palow and Boulay, Upper Pegu, in May and August.

Down the eastern coast I can find no records until one comes to Madras, whence the British Museum possesses an undated skin of Jerdon's and one of Davison's, dated April. Jerdon states in general terms that it is common in the Carnatic.

It remains now to treat of Southern India where as I hinted above there is apparently a change in the status of the Pied Crested Cuckoo which we have seen hitherto mainly as a rains visitor. Satisfactory details are however lacking.

According to Rhodes Morgan (*Ibis*, 1875, 315) it lays from March to May in Southern India, and Hume says that in the Nilgiris it appears to lay in January, February and March—the breeding season of the various local Babblers (*N. and S.*, ii, 388). The Hume collection contains an egg from the Nilgiris, dated February 22. Davison (*S. F.* x, 360) says it is a common bird in the Nilgiris, being most numerous perhaps about the cultivated land in the vicinity of Ootacamund, Coonoor, Kotagherry and similar places. He also saw it occasionally in the Wynaad and not unfrequently in the Mysore country. He says nothing of its status but specimens in the British Museum furnish dates as follows :—Coonoor August 23 ; Kolar, Mysore, April 13, 1868 ; Muddur, Mysore, May 22.

In the British Museum there is an egg taken at Aptoor, Salem District, on August 18, by A. G. R. Theobald.

South of this I find no more records in India beyond Jerdon's statement that it breeds at Coimbatore, but Hume obtained a female on March on Rameswaram Island (*S. F.*, iv, 457).

Cinghalese birds are now accepted as forming a separate race *Clamator jacobinus taprobanus*, but that of course would not necessarily prevent Indian birds being found there also as winter visitors. Legge's account (*Birds of Ceylon*, 247) is as follows :—' Widely

distributed over the low country of Ceylon, but is subject to a partial migration away from the wet regions on the western and south-western seaboard, during the prevalence of the S. W. Monsoon; Colombo, November and December. Arrives in Galle District at the same time. In the scrubby jungles of the Girawa and Magam and Pattus and throughout the Eastern Province, in the jungles between the Mahawelliganga and the coast, in the maritime portions of the north and west, as far south as Chilaw, it is a resident species, and is abundant in some districts. It is partial to those dry districts which are covered with low scrub, such as the neighbourhood of Hambantota, and many similar spots on the east coast, the Jaffna Peninsula, the north-west coast, and the island of Manaar, as also the Puttalam and Chilaw District. I have seen it occasionally in the interior of the northern division of the island, but it is scarcer there than in the maritime portion. It ranges into the Central Province to a considerable elevation, occurring in Uva upto 3,000 ft.; but in the western portion (to wit, the valley of Dumbara and adjacent districts) it is not found at such an altitude.'

Wait's account (*Birds of Ceylon*, p. 227) appears to be merely an epitome of the above but he adds that he has taken eggs from November to June and again in August. An oviduct egg was obtained in November at Puttalam (Legge, *S. F.*, iii, 366).

The Tweeddale collection contains seven specimens killed in Ceylon in November and there are two other specimens in the British Museum from Colombo, dated March 12 and December 28. Lewis records that he obtained a specimen at 2,300 ft. in the Balangoda District during the N. E. Monsoon (*Ibis*, 1898, 349).

I have now enumerated such evidence as I can find on the subject of the distribution and status in our area of the Pied Crested Cuckoo. It remains to summarize the results and see what deductions can be made from them.

It is quite clear that the bird is an abundant rains visitor for breeding purposes over a very large portion of India; that is in the Punjab and United Provinces with their outer Himalayan slopes, about the mouth of the Ganges, in Central Assam and perhaps in Upper Pegu; and again in Lower Sind, Mt. Abu and Central India and in the Bombay Deccan. Whether the extent of these areas is conterminous remains to be verified. The dates of arrival and departure are slightly variable but this is only to be expected with a bird whose movements are clearly connected with the rainfall.

It is also clear that the bird is very common in a patch of country about Mysore and the Nilgiris but its status here is not clearly recorded; and it is possible that this area is merely a northern continuation of the range of the Ceylon race *C. j. taprobanus* which appears to be a resident form with slight local migrations.

There is a huge extent of country from Darjeeling straight down the eastern side of the Peninsula to Bellary where I can find no information about the bird.

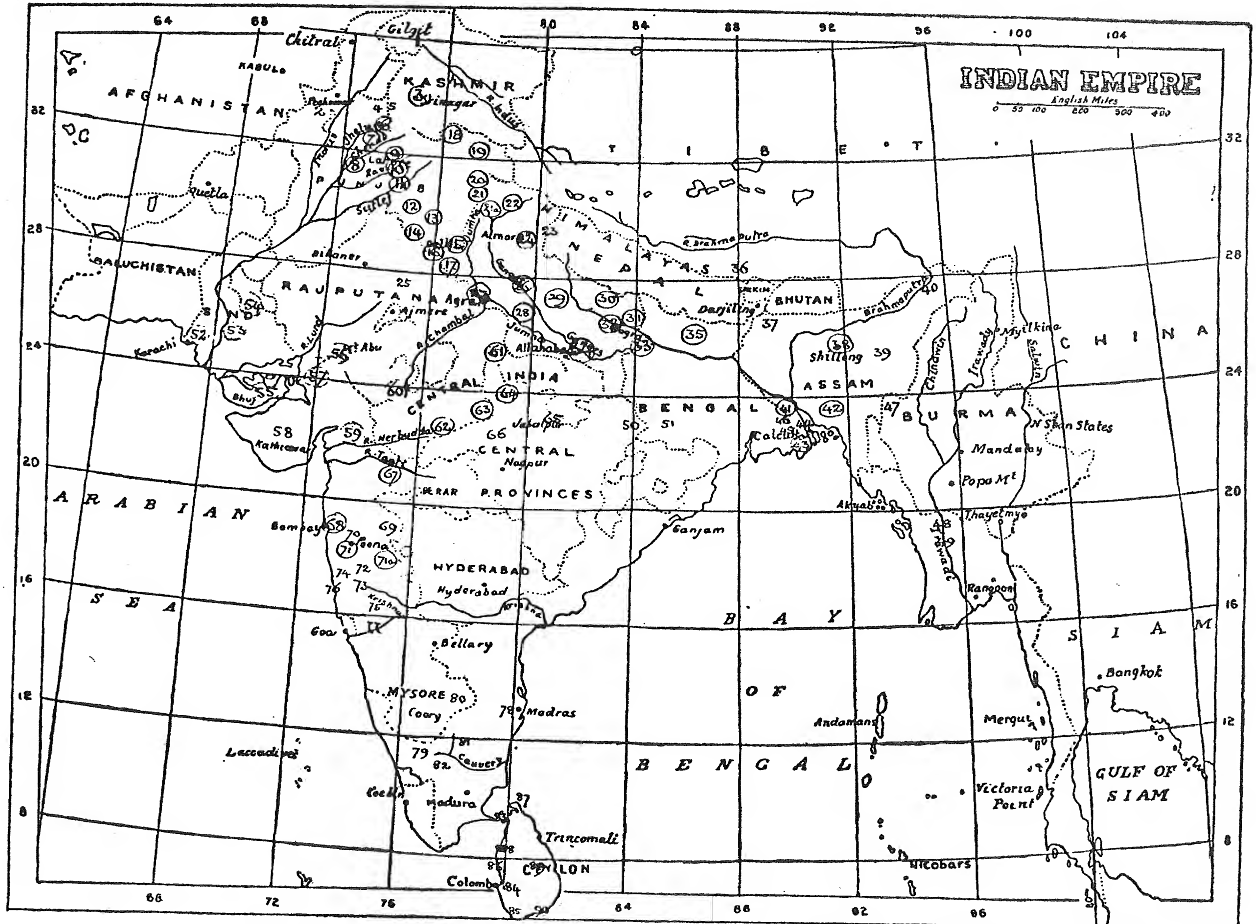
It is obvious therefore that we need a great deal more information about this bird in India, both as to its distribution and its status. It is so common, so easily recognized by its handsome plumage and

so conspicuous with its loud calls that much of the required information must be already in the possession of the members of the Society. May I ask our members to communicate either to me or to the Journal the information that they already possess, and also ask them to make notes on the occurrence of the bird for the next year or two in the neighbourhood of their stations. With more data it should then be possible to clear up the situation about this bird.

The point at issue is whether the Pied Crested Cuckoos which are rains visitors to a huge area of India winter in India or in Africa. A cuckoo absolutely indistinguishable from our bird is found in a considerable part of Africa, as well as other closely allied forms. It is possible therefore that our bird should be numbered in the small series of species which summer in India and adjacent areas and pass south by the Arabian route to winter in Africa. There are difficulties in the way of this view amongst which the chief is that the Pied Crested Cuckoo is believed to breed in parts of Africa and there lay a *white* egg, whereas in India the egg is now well known to be always *blue.* There is on the other hand the difficulty against the view that the Pied Crested Cuckoo winters in India that we cannot say at present where so great a mass of individuals can winter unrecorded; it can only be in Southern or South-eastern India or in Ceylon.

Legge's evidence appears to have ruled out Ceylon. As to Southern and South-eastern India we have no definite evidence either for or against the supposition. Surely some of our members can fill in the gap. Any information at all about any part of India will be most welcome, especially as regards areas not marked in the accompanying map.

BATTLE, SUSSEX,
January 10, 1928.



Map to illustrate the distribution in India of *Clamator jacobinus*.

The numbers indicate the places in the attached list where the bird has been recorded. Circles round the numbers indicate localities where the bird may be taken to be a regular Rains visitor,

Key to the localities indicated in the Map by figures :—

1. Gilgit.
2. Kohat.
3. Valley of Kashmir.
4. Rawalpindi.
5. Murree.
6. Jhelum.
7. Sargodha.
8. Jhang.
9. Gujranwala.
10. Lahore.
11. Amritsar.
12. Ludhiana.
13. Ambala.
14. Hissar.
15. Delhi.
16. Rohtak.
17. Gurgaon.
18. Kangra.
19. Kulu.
20. Simla.
21. Chakrata.

21*a* Dehra Dun.

22. Garhwal.
23. Naini Tal.
24. Almora.
25. Sambhur lake.
26. Fatehgarh.
27. Agra.
28. Etawah.
29. Lucknow.
30. Gonda.
31. Gorakhpur.
32. Fyzabad.
33. Mogulserai.
34. Allahabad.
35. Darbhanga
36. Tingri.
37. Jalpaiguri.
38. Shillong.
39. Gunjong.
40. N. Lakhimpur.
41. Fureedpore.
42. Dacca.
43. Calcutta.
44. Barrackpore.
45. Manbhum.
46. Birbhum.
47. Manipur.
48. Thayetmyo.
49. Prome.
50. Palamow.
51. Lohardugga.
52. Karachi.
53. Hyderabad.
54. E. Narra.
55. Cutch.
56. Mt. Abu.
57. Deesa.
58. Rajkote.
59. Baroda.
60. Neemuch.
61. Jhansi.
62. Mhow
63. Sehore.
64. Saugor and Damoh.
65. Jubbulpur.
66. Pachmarhi.
67. Dhulia.
68. Bombay.
69. Ahmadnagar.
70. Matheran.
71. Poona.

71*a* Valley of Bhima.

72. Mahableshwar.
73. Devrukh.
74. Dapuli.
75. Kolapur.
76. Ratnagiri.
77. Belgaum.
78. Madras.
79. Nilgiris.
80. Kolar.
81. Salem.
82. Coimbatore.
83. Rameswaram.
84. Colombo.
85. Galle.
86. Chilaw.
87. Jaffna.
88. Puttalam.
89. Mahawelliganga.
90. Mambantota.

A NOTE ON *VIVERRA CIVETTINA*, BLYTH.

BY

HELEN M. LINDSAY, M.A., B.SC.

(*With two plates.*)

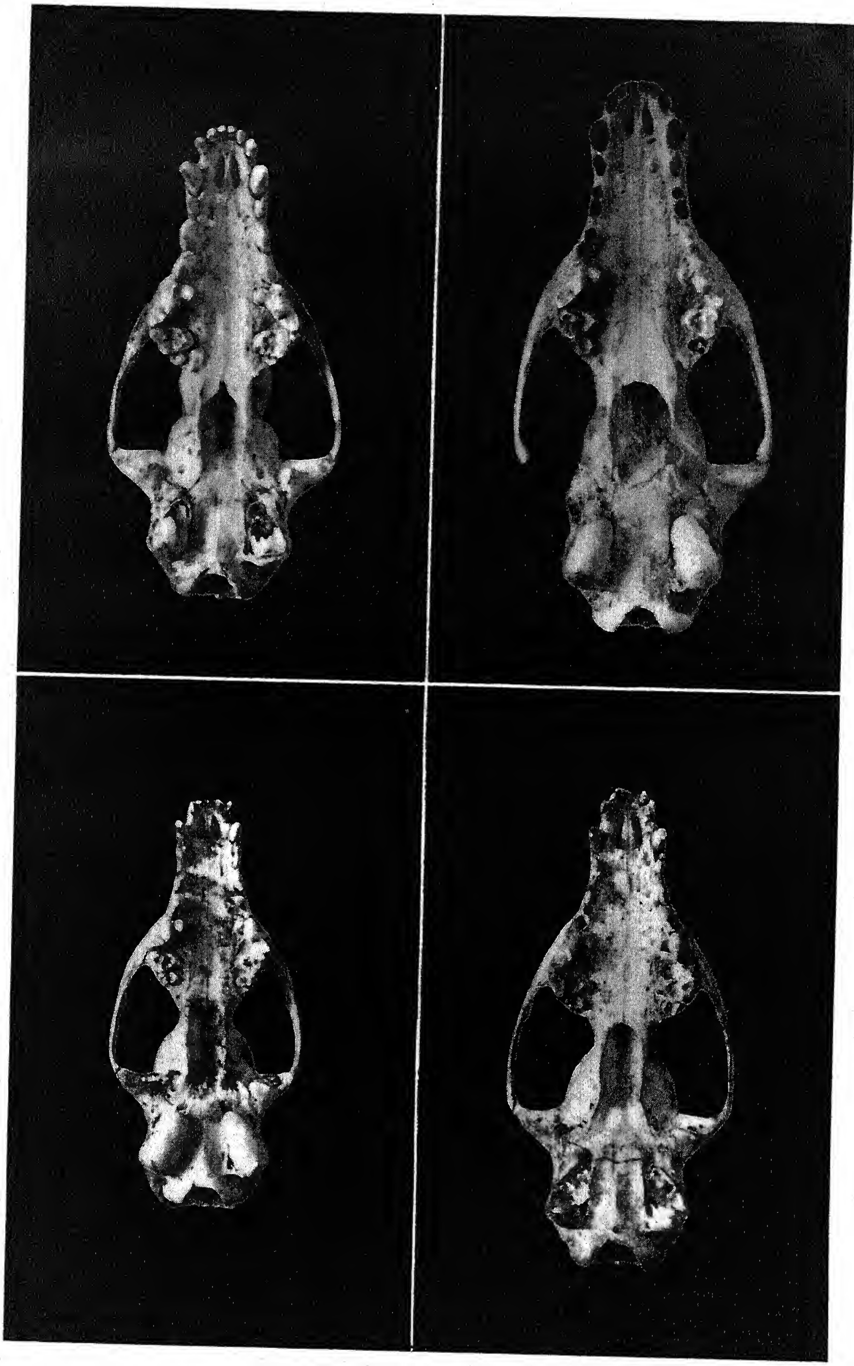
All who have written about the genus Viverra have admitted there are three well-marked species, viz. *V. zibetha*, *V. megaspila*, *V. tangalunga*, but some have cast doubt upon the existence of a fourth species—*V. civettina*. The latest paper on this group published by Robinson and Kloss in the *Records of the Indian Museum*, vol. xix, part iv, p. 175 (1920), makes out that there is a subspecies of *V. megaspila* which they call *V. megaspila civettina*. As I have had the privilege of examining the specimens of Viverra not only in the Calcutta Museum, but also specimens from the Bombay Natural History Society as well as those in the South Kensington Museum, I have been able to find that the species *V. civettina* does exist and is marked off from the other species by well defined characters.

The type specimen of *V. civettina* is in the Calcutta Museum, and is No. *b* of Sclater's catalogue. It was got in South India by Lord Arthur Hay and given by him in 1845 to the Asiatic Society, Bengal. It is a made up skin in very poor condition, split down the back, but the flanks, the feet, neck and enough of the tail to show the markings are quite intact. In 1863 Blyth in his Catalogue records this specimen 'in bad order'. At present the skin has a ground colour dull yellow and the markings are dark brown. The broken edges of the back show that the leather is also dull yellow, so no doubt the curing has affected the ground colouration and the spots. The upper jaw of the skull is in good state but the lower jaw has been broken. Where Robinson and Kloss made their error was in using the skull of the type but not its skin. In Calcutta there are three flat skins without skulls, which Sclater has in his catalogue as Nos. *a*, *c*, *d* of *V. civettina*, and one of these, probably No. *a*, must have been matched against the type skull of *Viverra civettina*. They report that two skins are true *V. megaspila* and these are two large ones marked *c*, *d*. in Sclater's catalogue. No. *a* was given to the Museum by Rutledge, who gave so many of the specimens of mammals in the Calcutta collection, but as he was a dealer in animals and kept a small menagerie he seldom or never noted on the label the locality whence the specimen came. This skin, No. *a*, is smaller than Nos. *c* and *d* but has the same markings and in absence of the skull which has such distinctive characters, or of noted locality, it must be called *V. megaspila*. Robinson and Kloss apparently used this skin, No. *a*, and either missed or ignored the type skin altogether.

In the South Kensington collection there are two skins and skulls which are undoubtedly *V. civettina*. One is a male adult, No. 20.1.17.3 from Trivandrum Zoo, which is the companion one to that in the possession of the B.N.H.S. The other is a younger creature collected by Sir Stamford Raffles and bought by the Museum at the Crisp Sale. Its register No. is 84.6.3.11. This skin tends to the dull yellow tint in the ground colour such as the type specimen in Calcutta shows. Both of these in skin and skull are identical to the type specimen.

The measurements of the male specimen from Trivandrum are :—Weight 14·5 lbs. ; length from tip of nose to base of tail 750 mm. ; root of tail to tip 330 mm. ; height at shoulder 305 mm. ; ear 51 mm. ; girth at shoulder 405 mm.

Regarding the distribution of this species Jerdon says, 'The Malabar civet 'cat is found throughout the Malabar coast from the latitude of Honore to Cape



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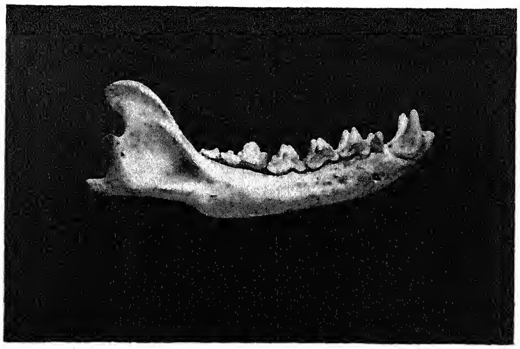
1. Upper Jaw of *V. civettina*—the type skull in Calcutta Museum.
2. ,, ,, *V. megaspila*—a skull from Bombay Nat. Hist. Soc.'s Collection.
3. ,, ,, *V. tangalunga*—in Calcutta Museum.
4. ,, ,, *V. zibetha*— ,, ,,

½ natural size.



1.

2.

3.

1. Lower Jaw of *V. civettina*—the type skull
2. „ „ *V. tangalunga*
3. „ „ *V. zibetha*

½ natural size.

(These photographs were prepared in the Indian Museum, Calcutta, through the kindness of Dr. Baini Prashad).

'Comorin, and very possibly it extends further north. It inhabits the forests 'and the elevated forest tracts of Wynaad, Coorg, etc. It is very abundant in 'Travancore whence I have had many specimens. I have procured it close to 'my own house at Tellicherry and seen specimens from the vicinity of Honore. 'I never obtained it from the Eastern Ghauts nor in Central India.' In 1923 Mr. A. P. Kinloch writing in the J.B.N.H.S., vol. xxix, p. 553, from the Nelliampathy Hills says, 'There is another Civet up here, judging from its 'droppings considerably larger than the toddy-cat, but I have never seen it.' The editor's note on this, 'It is possible that the large civet referred to by Mr. 'Kinloch is the Malabar Civet Cat (*V. civettina*) ———. This animal mea-'sures about four feet from the tip of the nose to the tip of the tail and its 'colouration approximates to that of the *V. zibetha* of Bengal and Assam. It 'is a dusky grey with large transverse dark marks on the back and sides, the 'throat is white and the tail ringed black and white alternately. The animal 'appears to be a most elusive beast and at one time its existence was in doubt. 'It is hardly represented in Museum collections. There was, and perhaps is 'at present, a mounted specimen in the Madras Museum. A few years ago 'the Society made an effort to obtain skins and skulls of this animal from 'members residing in South India. Eventually two specimens were obtained 'from the Travancore Zoo. Any further information or evidence in regard to 'this civet would be of interest.'

The colour of the Trivandrum specimen is dusky grey with dark brown spots which tend especially on the hind flanks, to coalesce into lines. Down the back from just behind the ears to the tip of the tail is a distinct band of almost black colour, which from between the shoulders forms the mane. There are three obliquely transverse black lines on the throat, which is pale buff grey like the area round the mouth, but underneath the chin is a patch of mummy brown like the feet and legs. The legs show faint markings of slightly darker tint. There is a brown patch on the ears close to the head. The tail is ringed alternate bands of grey and black, the black bands gradually growing larger as they near the tip of the tail, which is black. The grey bands are not more than 1/2 inch wide and are all broken on the dorsal surface by the band continued from the back. In skin the distinction from the other two spotted species is that the marks are not large, almost quadrate in form, and distinct from each other all over as in *V. megaspila*: nor small and distinct from each other as in *V. tangalunga*. Blyth notes in 1862 that in *V. megaspila* and *V. tangalunga* the spots tend less to unite into vertical bands or stripes on the side than in *V. civettina*. Thus on pattern of skin, which is the same on all the specimens examined, it must be put into a place by itself. The texture of the soft fur, together with the absence of the black patch under the eye and the presence of distinct rings on the tail, all mark this species off from *V. civetta* (now *Civettictis civetta*).

But it is not only the skin pattern that is distinct. The skull of *V. civettina* has several well marked characters. All writers about the skull of this species have noted that the first upper molar is more quadrangular than that in the other species. Sclater notes that 'its length has greater ratio to its breadth than in *V zibetha* where this tooth is almost triangular.' Robinson and Kloss say that the posterior upper premolar of *V. civettina* is larger than that of *V. zibetha* or *V. megaspila* and that the bullæ are more highly compressed. The postorbital processes of the frontal bones are almost absent in *V. civettina* whereas they are quite absent in *V. megaspila* and well developed in both *V. zibetha* and *V. tangalunga*. In the lower jaws pm^1 is close to pm^2 in *V. civettina* while in the other species there is a distinct space.

Another distinctive feature of the skull of *V. civettina* is the curve of the coronoid process. All four skulls of this species that I have examined agree in the pronounced backward curve of this part. Indeed on the variation of the coronoid process alone the four species of the genus Viverra can be determined for they form a complete series from the straight stocky shape, rising steeply almost at right angles both to the alveolus and to the condyle and squarely truncate above, of *V. zibetha* through *V. tangalunga* with a very slight backward curve of the front edge but still a straight back edge, and *V. megaspila* still more curved on the front edge but somewhat straight on the back to *V. civettina* with the long graceful backward curve from the alveolus and also deep curve in from the condyle on the back edge. I have examined four skulls of *V. civettina*, four of *V. megaspila*, twenty or more of *V. tangalunga*, and

quite forty of *V. zibetha* and have found these and the following features which may thus be tabulated :—

Name of species	Angle of coronoid process-relative to alveolus	Greatest length of upper jaw	Basilar length	Zygomatic breadth	Palatilar length	Length of bullae	breadth of skull at bullae	Depth of pm.^{2}
V. zibetha ...	74°	142	131	70	67	19	44	6 mm.
V. tangalunga ...	68°	122	112	59	56	19	37	5 ,,
V. megaspila ...	62°	152	138	70	78	21	42	7 ,,
V. civettina ...	55°	150	132	76	74	18	44	9 ,,

Thus on characters of both skin and skull it will be seen that *V. civettina* does differ considerably from the other three species.

Blanford mentions in his account of the genus Viverra in his 'Mammalia' that 'remains of two species of Viverra, *V. bakeri* and *V. durandi*, the last named larger than any existing civet cat have been found in the Pliocene beds of the Siwalik hills.' I have examined specimens of both these fossils and compared them with the corresponding parts of *V. civettina* and find that the upper jaw of *V. bakeri* possesses the same peculiar m^1 as is found in *V. civettina*, but m^2 is larger than that of any in the modern specimens. The mesopterygoid fossa with its sharp little tip is present in both *V. bakeri* and *V. civettina* but not in the others.

Schwarz concludes his paper 'Die indischen Viverridæ' in *Archiv für* '*Naturgeschichte*' of 1922 by stating that 'we must consider the modern forms 'of Viverra as the descendants of the Pliocene or their nearest forms of which 'fossils were known to us, first in Greece from Pikermi, from the Siwaliks and 'later in Southern France, in Sicily, Samos, in Maragha (Persia) and out of 'Schensi in Middle China. To-day in this zone, extending from 30°–45° N. 'there exists nothing of this fauna.' Lydekker in his book on '*Cats*' p. 291 says that 'in the Pleistocene cavern deposits of Madras this genus Viverra is represented by *V. karnuliensis*, a species about the size of the existing *V. zibetha*, but distinguished by the more elongated from of the premolar teeth in which respect it agrees with *V. bakeri*.' As *V. civettina* is the only species with elongated premolar teeth and since in two respects also it agrees with the fossil specimen of *V. bakeri* I think it is safe to conclude that *V. civettina* is the oldest representative of the genus and not *V. zibetha* as Linnæus considered.

Another proof of this can be found in Col. Meinertzhagen's paper on Ladakh in the *Geographical Journal*, vol. lxx, No. 2, p. 146. He says, 'It is an axiom 'that a discontinuous distribution represents isolated colonies of a once con-'tinuous distribution, and that the genus or species whose distribution is 'discontinuous is usually more ancient than the allied genera or species whose 'distribution is continuous.' He instances the case of the Tahr (*Hemitragus jemlaicus*) with forms known in S. India as *H. hylocrius* and in Oman as *H. jayakeri* with fossil forms from the Siwaliks and Salsette Island. The distribution of the genus Viverra is similar. and the isolated colony of *V. civettina* in Malabar survives as the representative of the old fossil form of the Siwaliks and Karnul.

MODERN MUSEUM METHODS

BY

S. H. PRATER, C.M.Z.S.,

Curator, Bombay Natural History Society

PART III

(*With seven plates*)

(*Continued from page 772 of Vol. XXXII*)

In the preceding article I have endeavoured to outline the method adopted by Museums to provide for the interests of the student class of visitors whose visit to the Museum is conceived with a definite purpose.

The type collection for University students, by the special character and arrangement of its exhibits, is designed to meet the needs of such students as are entering upon an academic study of Biology. It is also helpful to the lay visitor who may be desirous of acquainting himself with the principles and facts upon which this study is based.

The Children's Museum, taken either as a separate unit or a part of a museum, is a development intended expressly to meet the needs of less advanced students. It is an attempt to create a real interest in Natural History on the part of the young visitor by a definite effort to meet his special needs. The specialized nature of the exhibits arranged for his benefit, the manner of his reception in the museum, the pains taken and the methods employed to develop his interest and the encouragement he receives, indicate a further development in the Museum ideal of service to its visitors. The inclusion of both these features in a museum reveal a carefully conceived effort to raise the influence and educational value of its exhibits and to give them a greater significance and meaning to the visitor. These ideals mark a clearer recognition of the obligation the museum owes to the general public upon whom it is ultimately dependent for its support. It has been truly said that the so called public museum, which derives support from the people and recognizes its duty of service to the people, is of the dominant and most promising types at the present time.

Further developments on these lines are to be seen in the efforts made by museums to capture the attention and interest and thus to educate those of its visiting public who do not come to the Museum with any set purpose beyond that of amusement or recreation; people who constitute quite 90 per cent of the general body of visitors.

In the arrangement of zoological collections for exhibition in the galleries of a museum two distinct phases or interests in the

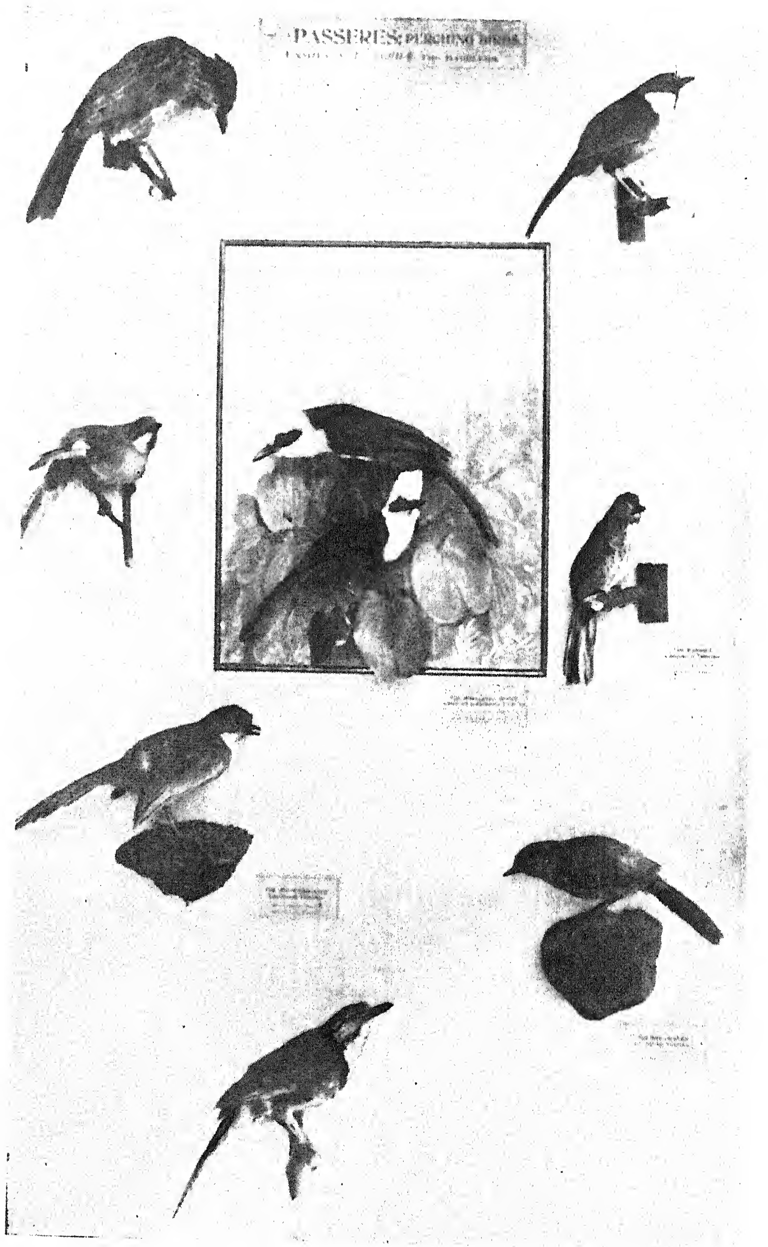
study of Zoology may be served. The first concerns itself mainly with the names and classification of species. This interest is served in the exhibition galleries of museums by what we call a systematic collection in which specimens exhibited as individuals, are named, arranged and classified in accordance with the families, genera and species. Usually an attempt has been made to include under this method of exhibition as many different species as were available and could be exhibited.

The second phase of animal study concerns itself with the significance of natural phenomena. It focuses attention on the life and habits of animals—on the relations between an animal and its animate and inanimate environment. It draws attention to such aspects of animal study as the relationship between the sexes, phases of social life, care of the offspring, the interrelation existing between structure and habits, etc.

An examination of the effect and the influence of these two types of exhibition on the general body of visitors leads to the following conclusion.

An exhibited collection of named and classified species has a definite purpose, a definite educational value. The classification of species is the basis of Biological Science. It is the foundation upon which all other branches of the science are dependent. If we are to study the natural mode of production or the development of a given animal or its relationship to other animals and plants—to the outside world, it is essential that we should be able to specify exactly the species of animal or animals with which we are concerned. Now the major interests of the Science of Biology are and can be served by what we term the reference collections of a museum—collections from which the general public are excluded and which are reserved for the use of specialists and advanced students. These collections when authorittively identified, classified and labelled serve firstly to preserve in a practical and economical manner, a safe and permanent record of various forms of animal life, which exist or have existed; which after all is the first purpose of a museum. Secondly, by their accessibility and by the manner of their arrangement, they are made available for the use of people who have the training and the knowledge to use them. So that information gained by their study may be used and applied directly in the service of man or for the advancement of learning. But when one comes to deal with collections intended for the general public, we aim at a totally distinct purpose which is the diffusion of knowledge among the masses. The principles governing the arrangement and exhibition of collections intended for the general public have been hitherto mainly the same as those adopted for the reference collection, except that cabinet specimens and flat skins are substituted by mounted specimens, which endeavour more or less successfully to portray the form and the character of the animals they represent, our aim being usually to exhibit by this means as many different species as conditions of space permitted.

What is the influence of this system on the main body of visitors and how far does it fulfill its educative purpose ? Frankly we are not out to make scientists out of our visitors ; our aim is rather education in its broadest sense. We endeavour to give them new



Shelfless method of exhibiting Birds as applied in the Prince of Wales' Museum. The method of introducing habitat backgrounds for individual species is also illustrated.

interests, to illustrate truths which are unknown to them, to give them a better understanding of life, its principles and relationships. Do we succeed? Is the basis upon which we build correct, or is a fresh orientation in our methods necessary for the effective fulfilment of our purpose?

Experience has shown that the great majority of visitors wander aimlessly through galleries containing this type of exhibits with unawakened interest and leave them in a while after a visit which has profited them little or not at all. It is difficult to sustain interest or create enthusiasm by a serried display of specimens, however interesting they may be individually, which by their very number and monotony of arrangement cannot but produce a sense of weariness and fatigue that rapidly kills any interest they may have originally created. To overwhelm the visitor with a mass of detail is to confuse the issue. If it is our intention to show how animals can be classified and how a given class of animals may be divided into more or less distinct orders, families, genera and species, could not this lesson be brought home more clearly by restricting the selection of the material to the more important types which would suffice to show the relationship between various classes of animals and define the limits of variation in a given class? This is where I believe the small museum as far as the general visitor is concerned is more effective in its teaching than the great National Institutions, as it is compelled to tell the same story in a fewer words and to give the visitor a better grasp of the subject as a whole.

A systematic collection can be made interesting and attractive; everything depends on the manner of its installation and presentation. The plea for more science in art museums and more art in science museums has its application here. The selection of specimens to be shown, their mounting and preparation for exhibition, the manner of their arrangement in the show cases, colours of background and labels—the show cases themselves require careful thought and study. The use of shelves for exhibiting specimens is a disadvantage as it tends to produce a monotonous lineal type of arrangement. The fitting of specimens to the background of the show case, or to a screen within the show case, by means of brackets and other devices which are not perceptible appears to be more satisfactory in as much as the system affords greater freedom of arrangement and lends itself to effective grouping and design. A photograph of a case of birds in the Prince of Wales' Museum illustrates this method of exhibition (Plate I). The colour of the background should be pleasing and yet not obtrusive. A matte black background, while it is effective, has the great disadvantage of increasing reflection and moreover when used in the mass strikes a depressing and sombre note in a gallery. Variation in the character of the mounts on which the animals are displayed is an important point. The limited use of paintings or photographs as individual backgrounds to selected species will add fresh interest and variety to the display. In the whole arrangement the principles of design should be observed and an attempt made to please the eye and to attract. A crude, overcrowded and unconsidered display will repel. In short we must, by practice and experiment, endeavour to arrive at a better

understanding of the full range of possibilities for the more attractive installation of science exhibits. In the selection and installation of these exhibits we must, I think, endeavour to distinguish between what is and what is not of practical value, particularly when we realize that we cannot expect people to take an interest in objects or principles displayed before them when these objects and these principles have no relation whatsoever to those to which they have been accustomed to give their attention.

This is why the second phase of museum exhibition, to which I have referred, makes a readier and stronger appeal to the average visitor simply because it concerns itself with 'life' and the living animal, in short, with something that is less abstract—more familiar and more tangible and therefore more likely to leave an abiding impression. It holds interest because the subject is one which has a definite relation to matters with which people are more familiar.

Secondly, the interest of the visitor is sustained because there is less danger of monotony in methods of presentation, as each individual phase of animal life, which one attempts to illustrate, will require individual treatment. Finally there are so many interesting facts in connection with the lives of animals that may be adapted to this method of exhibition and they are in themselves so varied and full of interest that their proper presentation in a museum cannot fail to rouse the attention of the least observant. They offer a channel through which the most casual visitor can be led, unconsciously perhaps, to a better understanding and appreciation of the world of nature. The exhibits in a Natural History museum make an appeal to the intellect, but the strength of this appeal on the majority of visitors will be considerably lessened or rendered wholly ineffective if they are to be made the victims of a tradition which countenances inertia and boredom as an essential and important part of any form of intellectual training.

Systematics is the basis of all Science and exhibits which illustrate this important branch of Biology must find a place in every museum of natural history. But it does not follow that they should be given a preponderance which prevents the inclusion of other features or limits them to an almost negligible quantity. The modern museum group which is carefully planned and has a definite story to tell and a definite fact to reveal, contains all the essentials for arresting the attention of the visitor, educating him and compelling him to take away at least something of what he should from his visit to the museum. The factor on which the modern museum group depends largely for its success is one which makes a universal appeal—a love of beauty is common to all and affords the simplest method of attracting attention which is the preliminary to all successful instruction.

The museum group may be used to illustrate a variety of facts and theories and principles bearing on the study of animal life. It may illustrate the life history of an individual animal, or give a vivid portrait of the animals characteristic of a particular region ; it may be used to show the relation between an animal's colour and its environment or indicate how it is adapted by its

structure to a particular mode of life. In fact the subjects, which may be selected for illustration are so varied and so numerous that their selection must be governed by conditions of space.

As the first purpose of a group is educative, it follows that it must be truthful; it must be based on actual studies made in the field and constructed with the help of field notes, paintings, sketches and camera studies which will form a guide to the faithful recording of the subject which the group is intended to portray.

The background of the Museum group is not imaginary but is painted from nature to illustrate the actual character of the country in which an animal is found. It must be quite as correct and as typical of the country as are the animals which are to accompany it. The foreground of a group which is made to join imperceptibly with the background must carry forms of plant life and other accessories which will faithfully portray an animal's immediate environment. It necessarily follows that a group designed on these principles, in addition to illustrating various aspects of animal life, also possesses the value of giving the visitor an idea of the varied physical characters of a particular country. In India for instance it would be possible to secure the necessary material and accessories for groups depicting a large range of Indian animals in the Nepal Terai but such a course would fall short of giving the visitor an idea of the widely diversified types of country to be seen in the Indian continent.

The Making of Museum Groups

Field Work : Painting the Background

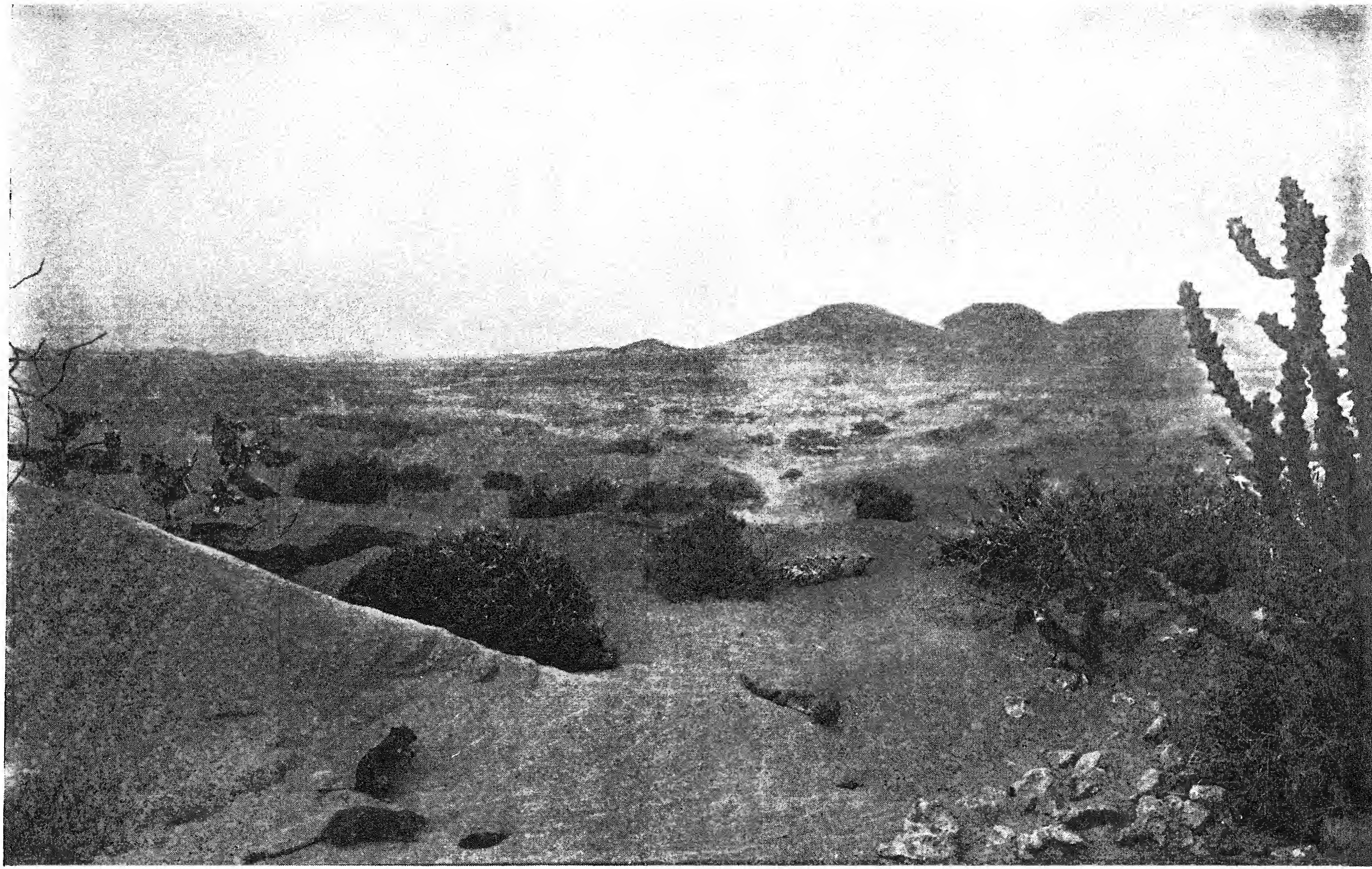
A description of the methods in use for obtaining the material for the construction of museum groups would be useful perhaps to those who have not had previous experience in the work and would also give the general reader an idea of the amount of care and labour expended in the production of the modern museum group. The writer recently had the opportunity of joining an expedition organized by Mr. A. S. Vernay for the purpose of painting backgrounds and obtaining the necessary material and accessories for a series of groups illustrating the game animals of India, which Mr. Vernay is presenting to the American Museum of Natural History, New York and also for providing similar material for the Prince of Wales' Museum, Bombay.

A collecting expedition of this nature is generally headed by some official of the Museum, under whose direction the groups are to be constructed. He is the man who knows what is wanted and will guide the selection of the backgrounds and other material. The experience he gains in the field will help him in supervising the subsequent work in the museum galleries. If the animals are to be collected it is important that the personnel of the expedition should include the taxidermist to whom the work of setting up the animals will be subsequently entrusted. The taxidermist will thus obtain first hand knowledge of these animals and will be able to take his notes and data in the field. For painting the backgrounds the services of a competent artist are necessary; preferably one who has specialized in landscape work and, as artists are highly temper-

amental people, preferably one who is amenable to suggestion and will submit questions of style and individual technique to the achievement of the actual purpose for which the painting is required. Finally a photographer is required who, in addition to his work with the camera, should have knowledge of the handling and treatment of accessories in the shape of plants and other objects which are to be collected in the field. In the present instance the animals for the groups had been collected on a previous expedition and a taxidermist was not included. A description of the work done in obtaining material for a group of Brow-antlered Deer in Burma will indicate the lines on which the work was conducted in the field. Our headquarters were at Taungdwingyi in the Magwe district and from there we motored out about fifteen miles to collect material to paint backgrounds for this group. The type of country inhabited by Thamin in this part of Burma is low scrub jungle interspersed with trees. Though the country immediately surrounding the town was much of the same character, we motored out a bit so as to get outside the human influence. Our guide in this instance was a forest ranger who was well acquainted with the ways and habits of Thamin and with the country in which they were found. On arrival our first consideration was, as always, to select a suitable view for a background. A great deal of time was always devoted to this preliminary step upon which the ultimate success of the group mainly depends. If there is sufficient time for the purpose it is advisable to devote the first day to a general reconnaissance of the country, during which, various likely spots may be marked and the best and most suitable one subsequently chosen. The object is to paint a picture or pictures which record the character and colouring of the country in which Thamin are found. This picture is to be used subsequently as guide in the composition of the painted background in the Museum. The painting is supplemented by photographs which will supply a more faithful record of the detail. Three general rules govern the selection of a 'view'. Firstly it must contain the necessary elements, which make it typical of the country one is attempting to portray, secondly it must be practicable for the purposes of a group, lastly it must make a 'picture'. No. 1 is essential in asmuch as it gives the natural habitat of the animal. No. 2 is equally necessary if we are to reproduce the habitat within the limits of a show case. No. 3 supplies that element of the picturesque and the beautiful which must go into the making of a successful group. These three factors are interrelated; a scene might be characteristic and beautiful but it may not lend itself to group construction. This factor always presents a good opportunity for a clash between the artist and the practical man. In all groups pertect continuity and connection must be maintained between the built up foreground and the painted background; for this purpose both harmony of construction and harmony of colour are required. As the museum group generally implies the portrayal of a wide area of country within the limits of a show case, the group constructor has several difficulties to overcome before he can produce the desired effect. The background selected must have 'distance' if the entire perspective is obscured by objects in the middle ground or

PAINTING BACKGROUNDS FOR HABITAT GROUPS.

The above photograph shows our own and the New York Museum artists at work in the field (Vernay-Faunthorpe Expedition, 1927–28).



SIND DESERT GROUP.

The observer is looking across the desert to the distant Khirthar Range.
Background painted by K. B. Savardekar. Group exhibited in the Prince of Wales Museum, Bombay.

foreground of the painting then the feeling of depth is lost. At some point therefore the 'view', one selects to paint, must afford a sense of perspective both in colour and form. When there are mountains in the distance these can be effectively used to produce the effect, but when these are absent a view of the distance must be supplied through some opening or openings between the trees or other objects n the foreground. One of our difficulties in painting the background to illustrate the habitat of the Small Two-horned Rhinoceros was that the creatures elect to live in a jungle composed mainly of a dense and impenetrable mat of climbing bamboo known locally as *wa-tabut*. It overwhelmed one on all sides and one could never get sufficiently away from it to paint it or see more than a few yards through it. Here the artist had to be content mainly with taking colour notes and recording the general character of the jungle as seen from an elevated point and to depend ultimately for detail and composition on the numerous photographs that were taken. In painting the backgrounds for the Thamin our chief problem was the monotonous and drab nature of the country which afforded few salient features to help in composition and to provide those 'incidents' which give a picture its interest and attractiveness. Quite often it is not possible to find all the elements for the painting of a background in a single spot. If one required a picture of a river with sand bars, flanked by tall plume grass and backed by heavy forest and low hills, as a setting for a group of wild Buffalo, one may find it difficult to discover a spot which combined all these features in a manner which would be adaptable to the requirements of the group. The difficulty can be overcome by making separate studies of these various features which could be used by the artist in composing his final painting in the museum. While in New York, I had the opportunity of studying several sketches made for a background of a group illustrating life on a coral reef in the Bahamas. The artist first made colour sketches of the sea, recording the yellow green of the shallow water and the gradual change of the colour tone till the deep blue of the sea on the horizon was reached. Other studies recorded the form and colouring of distant islands. In the middle of the foreground there was to be a coral reef. Studies were made of this reef first in the broad mass for colour tones and for the grouping of the trees and rocks. Then detailed colour studies were made of its various features. Now these separate studies will form a guide to the artist in composing his final painting in the Museum. The accompanying photo graph illustrates the completed background for a group of Wild Turkey at the American Museum of Natural History, New York, together with the field studies which were used in its composition. I have also illustrated a group of Brown Pelicans to show how the built-up foreground with its mounted birds can be made to merge imperceptibly into the background and thus cleverly give a graphic picture of the vast colonies in which these birds breed.

Painting backgrounds for groups implies the use of vigorous detail in the foreground of the painting. The trees and other objects are made to stand out definitely so as to harmonize with the

real objects in the foreground of the group. Backgrounds should be colourful and lively otherwise as a scenic representation they appear dull and flat and do not produce the true note of light and colour of an open air scene.

Mr. R. W. Leigh who was one of the artists deputed by the American Museum to paint a series of backgrounds for groups of the African Hall in writing of the requirements, for the type of work indicates that the background to a group of animals calls for the utmost measure of truth in painting 'There is no room for individuality as expressed in treatment or in style, for it aims to suggest paint as little as do the mounted animals. But in the suitability of tone, colour, and line, in the massing of light and shade, the catching of character and form, the rendering of texture, the achievement of the illusion of realism and the forgetfulness of painting, there exists a challenge' Mr. Leigh concludes 'which would test the skill of the finest artist'. The actual time for painting in the field is necessarily limited by prevailing conditions of light and the effect one desires to record. Painting time *per* day for a particular scene is usually limited to a few hours. In painting the interior of a forest in Mysore, we found the most suitable time was between 10–12 a.m., while a shola-covered hillside showed up best between 4 and 6 in the afternoon. As the time at our disposal was limited we were not able to give more than two or three days to obtaining material and paintings for a particular group and time was saved by working at two separate groups in a day one in the morning and another in the afternoon.

Photographic Work

Once the venue for the artist's work has been decided on, the photographer commences to make studies of the "view" selected for the painting, endeavouring to take pictures which will supply a record of the complete panorama, as the artist's picture painted in the field will generally depict only a small portion of the scene. His photos will also supply details of the landscape, of the various trees and other objects it contains, which the artist will not be able to supply in his painting. These camera studies are intended as a guide to the construction of the group. They help in the final composition of the picture and will supply a true record of the formation and character of various objects to be reproduced both in the foreground and background of the group and furnish important details of light and shade. In addition to panoramic views recording the general character of the country, separate photos are taken of individual trees, shrubs and such details of the ground as will help in reconstructing these 'incidents' in a group.

Perhaps the best camera for field work of this description is a quarter plate revolving-back Auto-Graflex fitted with a Zeiss-Protar lens. This type provides a doubly convertible lens of either 8″ or 14″ focal length. With it one can enlarge a small object or reproduce it the actual size by using the two components individually or in combination. The covertibility will be found very useful in photographing distant views such as a distant line of mountains.

These would naturally appear very small, and devoid of detail with the short-focus combination but could be considerably magnified by using a single element. A strong wooden tripod which folds compactly is an indispensable part of the equipment.

Collecting Plants and Accessories

The foreground of a group portrays the immediate environment of the animal or animals shown in it. In trying to give the true character to this setting one must select such material, in the shape of plant forms and other accessories, as would suffice to give a correct impression in the *simplest* way. It is unnecessary to reproduce everything one finds in a given spot. Select only those particular features as give the requisite character to a given bit of ground and suffice for the purpose.

As this material has to be moulded, cast and then reproduced in wax it is wise to select such types as will readily lend themselves to this method of reproduction. In selection therefore shape, colour and reproducibility are taken into consideration. As regards shape when there is a wealth of material to choose from, beauty of form might guide selection. As regards colour one should endeavour to visualize the colour notes to be struck in the group: particularly in relation to the animals which are to be exhibited in it. The plants selected for inclusion in a group should be brought into camp as carefully as possible, care being taken to prevent them from being damaged on the way. On arrival they should be put into water to prevent shrivelling or wilting. Some plants are so delicate that they wither very soon; experience will soon show that these should be collected last to reduce the time between collecting and preservation.

The purpose of field collecting is to bring back to the museum, such records of the form, shape and character of various plants, trees and other accessories as will help in the building and reproduction of the groups in the museum. For the above purpose

(1) Specimens should be preserved in formalin.
(2) Notes recording their colour and form should be made.
(3) Plaster moulds recording their form should be taken.

For preservation and transport of plant specimens in formalin, cylindrical zinc drums with close fitting lids will be found useful. These drums are made so as to fit one into another for easier transport when empty. When packed with plants ready for despatch the greater portion of the formalin is drained out of them and they are soldered and then crated. A convenient size of drum is one measuring 2′ 6″ × 15″. A 4–5 per cent solution of formalin will be found useful for preservation of specimens in the field.

Smaller plants and bushes.—In collecting material for the reproduction of a given plant, it is necessary to preserve whole in formalin small branches and twigs to show the character of the growth. For purpose of preparing moulds of the leaves in the museum a selection of various sized leaves should also be preserved in this solution. Fruits and flowers, if available, are also taken.

The specimens are carefully bound together in separate lots and labelled with a numbered wooden label; they are wrapped in cheese cloth to prevent damage before being placed in preservative. Portions of plants such as the stem and branches if they will dry well are cut into sections, numbered and packed separately. A record of the material preserved in each tank is kept in a note book.

Trees.—When a tree is to be reproduced, a section of the bark is preserved to show the character. If some of the branches are required, these are cut into sections and the sections numbered as a guide to fixing together. Leaves, etc. are preserved in the same way as with smaller plants.

Small vines are collected whole.

Large vines are cut into sections and preserved. Formalin specimens are kept of the leaves, etc.

Rocks.—Samples are taken to show colours and forms.

It is important to have photographic records of the various species collected as a guide to reconstruction.

In collecting material for a given plant, it is best to collect several specimens, i.e., one lot for preservation immediately in formalin, a second for colour notes and a third for casting.

The preservation of plants, etc., in formalin is perhaps the most important part of field work, because from the material so preserved, careful casts and reproductions can be made in the museum.

Colour Notes.—Colour notes of the leaves, flowers, fruits and other accessories collected for a group are equally important as they form the only record of the actual colouration of these specimens. The colour notes consist of careful sketches made in water colour of various parts of a plant; various phases of the colouration of the leaves, fruits, flowers are recorded. The sketches are supplemented with such written notes as might be helpful and form a guide to the colouring of the plant models. We have found that careful pencil sketches illustrating the precise formation of a tree trunk etc. are an excellent guide in the subsequent building up of the trunk. A photograph may not always afford sufficent detail for this purpose.

Flowers.—In addition to colour notes a record or pattern is made of the shape and size of the various parts of any flowers that may be collected. The flower is dissected and an exact pattern is taken of the petals, and other parts etc. The patterns are invaluable in the reconstruction of the flower in wax.

Moulds

Plaster moulds of leaves, etc. serve as records of the shape and character of plant forms, etc. collected in the field which would be useful if the material preserved in formalin was damaged or destroyed before casts could be taken from it in the museum laboratory. If one could be certain that the formalin specimens would arrive in a good state of preservation then the necessity for taking moulds in the field would not be so urgent as the work could naturally be done better in the museum.

In taking moulds of leaves one should select typical leaves of

varying sizes. The leaf is laid on a bed of plasticene with at least an half inch margin all round. Too large a margin implies wastage. The leaf is not pressed flat but its natural contours are preserved by building up plasticene underneath them. Air pockets between the leaf and its bed must be avoided. The leaf must lie securely on its bed so that no plaster flows under the leaf when casting. Keep the leaf dry and clean and avoid pressing upon it in any way. A dam composed of a ribon of plasticene is put around the claybed. It should be sufficiently deep to keep the mould durable. The mould should be at least $1\frac{1}{2}''$ thick. Liquid plaster is poured along the centre of the leaf which slowly spreads and covers it entirely, thereby avoiding any air bubbles. Then more plaster is added; when the plaster has set the dam is removed.

This briefly covers the actual work done in the field, but it will be seen that the varied character of the work and the varied character of the material collected will offer individual problems. Though the work may vary the principle remains the same. The purpose of this field work is to bring back to the museum a true and faithful record in the shape of paintings, photographs and actual specimens which furnish the requisite material for building up a faithful and at the same time beautiful presentation, illustrating of the manifold forms of animal and plant life of a country. The man who goes out to build groups must familiarize himself with the details of the group by actual observation in the field; as an aid to his memory and to retain the impressions he has gathered, he must collect the material which will guide him, make sketches, take photographs, etc., but the essence of the whole subject is that he must be able to visualize and carry with him the essence and the spirit of what he sees so that a subsequent work might bear the impress of beauty and truth.

Work in the Museum

The building of the group in a museum should commence as soon as possible after the return of an expedition, when impressions are still fresh. The first step is to build a scale model of the group as it will eventually appear. A scale of two inches to the foot will generally suffice. The model itself is built as simply as possible. The portion representing the front of the case is made of card board with a window in it cut out to scale. The curved background may be made of a sheet of tin or zinc. It is given a coat of white lead to give a surface for painting on. The model forms a starting point from which improvements may or may not be made when building the actual group, so a strict adherence to scale is essential as it gives an idea of the space available, prevents subsequent overcrowding and gives some idea of the effect which will be obtained. In planning the setting of the group one must have an idea as to what animals are to find a place in the group and the manner in which they will be mounted and the purpose of the representation. The background should be painted in and the trees and foliage of the foreground built in and composed to produce the desired effect. Scale models of the animals are also introduced so that the whole effect may be judged, corrected and altered till a pleasing and attractive picture is obtained.

Trees and other accessories intended for the scale model may be either built up or cut out of card board and coloured. Animals seen in profile may also be treated in this manner. It saves time.

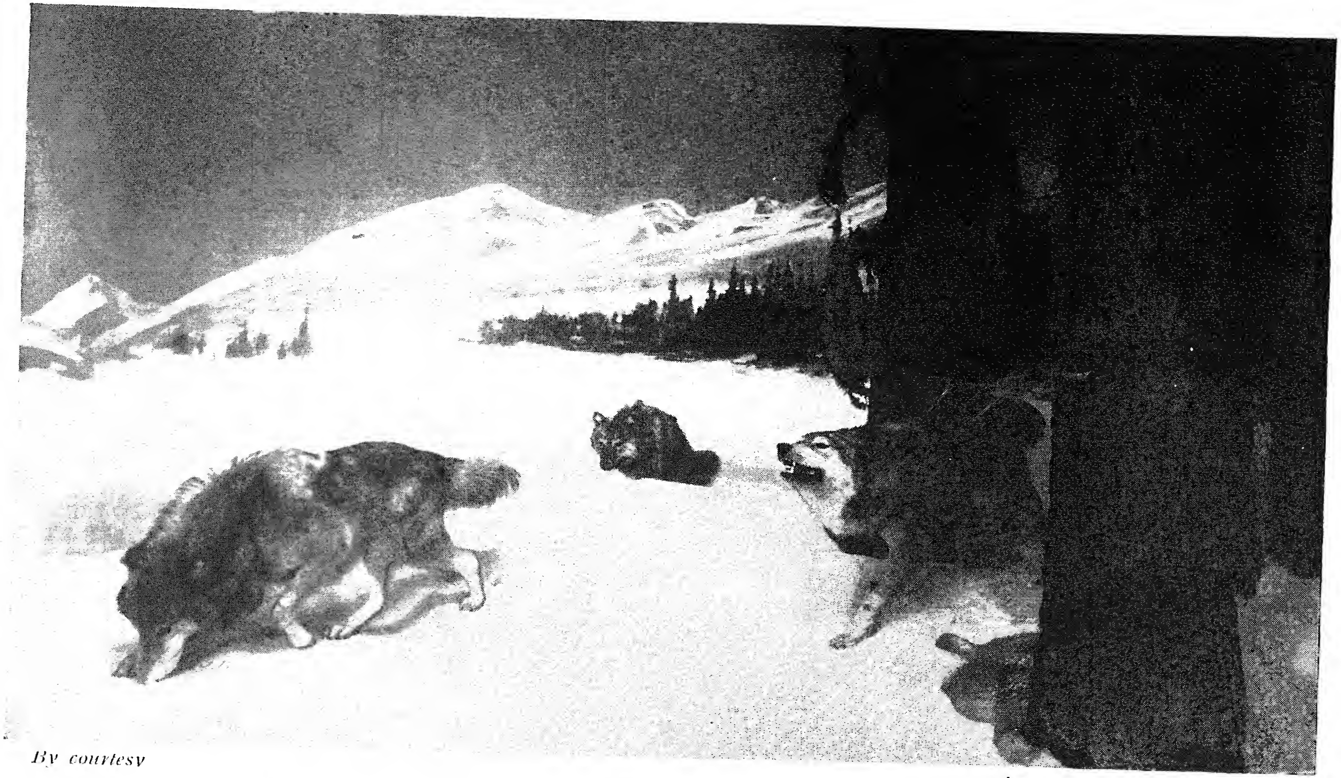
Twelve examples of a given group may be made by twelve different men yet one of them will stand out because of its sheer artistic merit; because the author will have caught not only the subject but also its true atmosphere, the spirit which gives it life. The keynote of group work should be simplicity. The accessory work should be kept down to the minimum possible for reproducing the correct 'atmosphere'. The objective being to suggest with as little material as possible the picture you wish to portray. Accessories must always remain a subordinate feature in a group. They are intended only as a setting to the animals and should never become the main attraction. This is excellently illustrated in the group of Timber Wolves (Plate) which is one of the most successful groups in the American Museum at New York. Simplicity has been the key note of the composition, accessories have been limited and the principles of design and perspective have been attractively maintained. Further, and this is an important point: the group does not complete the story, it leaves the climax to the imagination of the visitor; the wolves are tracking their prey through the snow, the success or failure of the hunt is still in suspense.

The foreground of a group is made on a separate base and is made so as to rest on the floor or is held in place by supports fitted to the side and back of a case. The foreground should preferably be built with a gradual upward slope. This gives a better sense of perspective. The angle at which the foreground should rise to meet the background can only be determined by experiment—a rise of one in ten will usually be found satisfactory.

A depression in the foreground at the point where it joins the background, so that the actual line of junction is hidden will be effective in giving continuity to a season. A gap left between the foreground and the background is effective in giving an illusion of distance. The effect is astonishing even in a small group.

In a previous article I discussed methods and means employed for the construction of cases and backgrounds for groups and the question of artificial illumination. When artificial illumination is not used the lighting within a small group may be greatly improved by placing the group against a window. If the case has a ground glass roof a reflector should be placed above it at the required angle. A good volume of light can be thus thrown into the case.

Artificial illumination adds very much to the effectiveness of a group. By its use varied effects, such as sunset, dawn or moonlight might be produced. By increasing the volume of light within a case reflections on the glass front of the case are considerably reduced. Shadows within the group are obviated by having the light directed towards its ceiling and then deflected downwards. Cross lights from the side of the case will also help to obviate shadows. Spot-lights are effective in concentrating illumination on any desired part of the group, such as lighting up part of a hillside or clouds, etc. When artificial illumination is used it is essential that provision



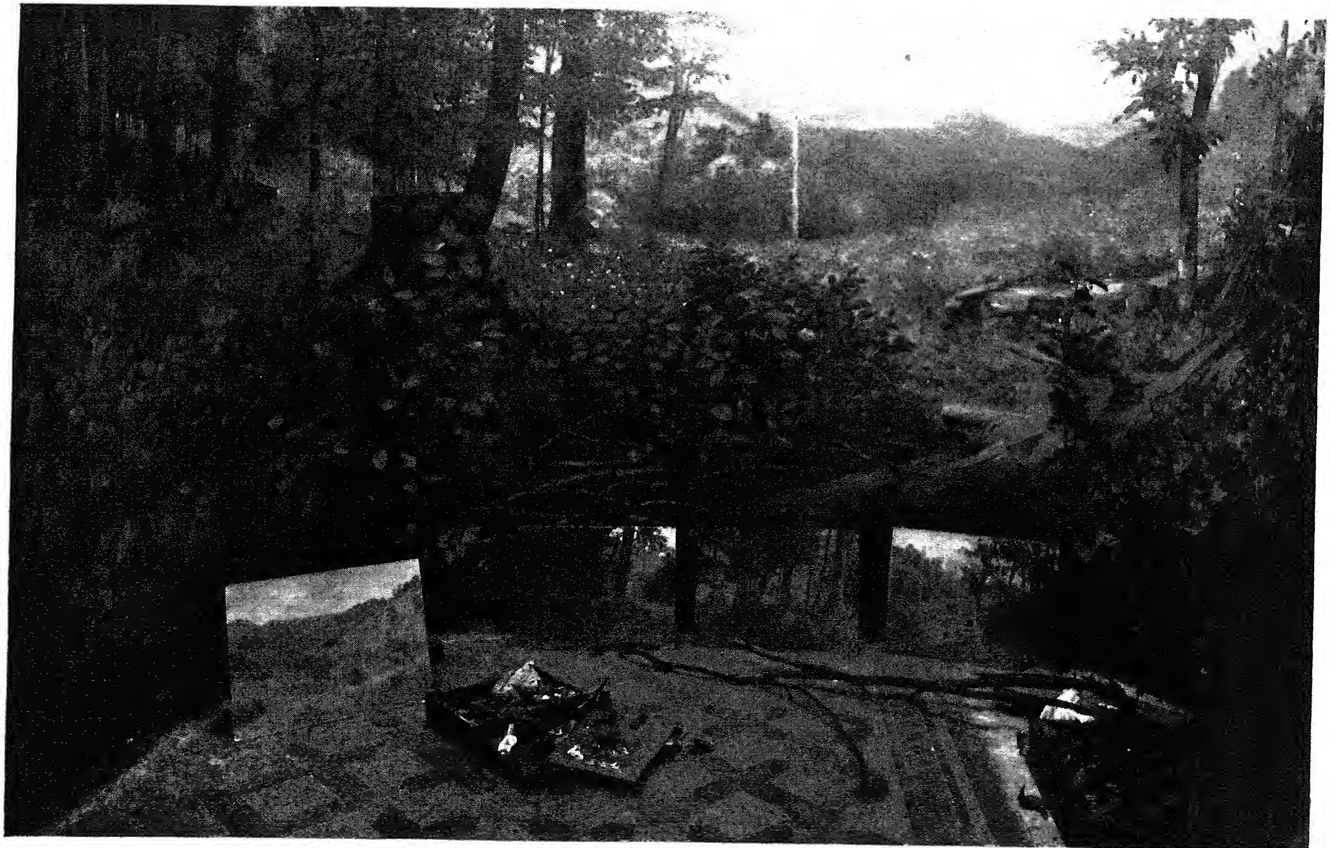
By courtesy *Amer. Mus. Nat. Hist. N.Y.*

GREY OR TIMBER WOLF GROUP.
American Museum of Natural History, New York.

By courtesy *Amer. Mus. Nat. Hist. N.Y.*

BROWN PELICAN GROUP.

American Museum of Natural History, New York.



By courtesy *Amer. Mus. Nat. Hist. N.Y.*

Background for Wild Turkey Group, showing the field studies used in its composition.

Case illustrating how a snake poisons its prey. Shows how models, specimens, etc., can be used in combination with the subject matter of the group.

Case to illustrate breeding habits of Snakes. A Cobra with eggs in a deserted Termite nest. (Photographs of exhibits in the Prince of Wales Museum, Bombay.)

should be made for the heated air within the case to escape. A ventilating cylinder made of tin or some other suitable metal, partially plugged with cotton placed at the top or side of the case, where it is not seen can be used effectively as an outlet for air.

Small Groups

Though many of the groups exhibited in a museum are of a large size and take up considerable space, a great deal can be achieved, particularly in small museums, by the preparation of small groups which can as effectively teach their lesson. They are particularly suitable for the exhibition of reptiles, insects and the smaller forms of animal life. Miniature groups for illustrating even the larger animals have been advocated. The specimen here being represented by miniature models. There is no doubt that many facts in animal life can be told by well-designed miniatures. The objection to this method is that the visitor would not get a true idea of the size of animals exhibited in which sense the group would be misleading.

The principles of construction are the same as those followed in the large groups. Small groups may be shown individually or arranged in a series. The lesson a group is designed to teach or the story it tells might be emphasized or enlarged upon by the use of insets in the shape of specimens, diagrams or models. Two groups recently prepared for our Museum to illustrate oviparous and ovo-viviparous habits of snakes have insets showing the development of the snake within its egg and a diagram illustrating the function and purposes of the egg tooth. Similarly models, specimens and photographs to illustrate the dentition and poison apparatus of snakes are used in combination with a group showing a saw-scaled viper swallowing a rat. The title of the group is 'How Snakes Poison their Prey—the visitor is attracted by the main subject of the group, his curiosity and interest once roused he is led to examine the specimens which are shown in combination with it and thereby learns the whole story the group intends to teach. In all probability if these insets were shown by themselves they would have escaped his attention ; or they would not have roused him sufficiently to induce him to examine the specimens, read the labels or gain the knowledge it was intended that he should by their exhibition. One of my most gratifying experiences in the museum was a crowd of coolies collected round a snake group listening with great interest to one of their number who read to them the contents of the vernacular label which explained the purpose of the case. I have not the slightest doubt that their interest was roused by the manner in which the subject was presented. As I have endeavoured to point out in the course of the article ; if the visual instruction which the exhibits in a museum are intended to convey is to be effective on the mass of the visitors, if their significance or influence is not to be lost on the majority of those who come to the museum, then every attempt must be made and every channel explored whereby their attractiveness might be increased and the appeal strengthened.

The museum can be made gateway to various kinds of paradise,

to a release from sordid thoughts, the ever present and too pressing cares of life. It should afford the coveted chance of seeing interesting things beautifully told. The museum ideal is to create a place of beauty where all forms of loveliness would be at home; where the beauty of surroundings, of arrangement, would enhance the charm of an individual object. This blending of objects and surroundings with a warm-hearted intelligent desire to serve would then develop a tangible spirit which speaking through the sensibility would come to be recognized as the 'Spirit of the Museum'.

(*To be continued.*)

A NOTE ON THE WORK OF NATURE STUDY TEACHING AT THE PRINCE OF WALES' MUSEUM, BOMBAY, FROM 16TH NOVEMBER 1926 TO 10TH FEBRUARY 1928.

BY

SALIM A. ALI, M.B.O.U.,

Assistant Curator, Bombay Natural History Society and Guide Lecturer in Natural History, Prince of Wales' Museum, Bombay.

(With a plate)

THE scheme for holding Nature Study classes at the Prince of Wales' Museum, Bombay, which has unfortunately come to an untimely end due to the financial stringency with which the Government of Bombay are faced, owed its inception to proposals put forward by the Bombay Natural History Society in co-operation with the Education Department and accepted by Government in their Resolution No. 254, dated 8th December 1924.

Para 3 of this Resolution provides 'that a Lecturer shall be attached to the Museum who would instruct parties of School Children.'

In consequence of the above Resolution there were several discussions between the representatives of the Society and the Educational Department, as the outcome of which it was agreed that a competent man should be appointed by the Society (with the approval of Government) who could lecture and demonstrate to parties of children from the local schools. The salary of the lecturer would be provided by an annual grant of Rs. 5,000 from Government, and it was hoped that in time the Municipality would also contribute. The proposals agreed on were placed before the Trustees of the Prince of Wales' Museum at a meeting held on 22nd December 1925. The Trustees were in full accord with the project and provided a special room for the purpose of these lectures. It was arranged that all the expenses of the scheme should be borne by the Sub-Committee of the Natural History Section out of the special grant to be made by Government for the purpose.

Unfortunately Government were at the time unable to make the requisite financial provision, but the Society was fortunate enough to obtain a special donation from the Sir Sassoon David Trust Fund and also from the N. M. Wadia Charities, which donations enabled them to take up this work with the schools. The work was undertaken by the Society, however, on the definite understanding that when the monies obtained from the above sources had been expended, suitable provision would be made by Government for the work to be carried on in the future.

As the result of a number of conferences between the representatives of the Society and the Director of Public Instruction, the Principal of the Secondary Training College sent out at the begin-

ning of October 1926 a circular letter to about 30 Ango-Vernacular Secondary Schools in the City informing them that it was proposed to hold a course of nature study demonstrations in the Natural History Section of the Prince of Wales' Museum, and asking them, in case they desired to admit any of the classes from their schools to these, to communicate for particulars and appointments with the Guide Lecturer who had been specially appointed for the purpose.

In response to this circular, applications were received at the time and during the period the scheme was in operation, from 21 schools for the admission of 44 classes in rotation to the Museum nature lectures. Of these, three were girls' schools, three mixed boys' and girls' and the rest boys'.

Two classes were held daily, barring days when the Museum was closed to the public, holidays and school vacations, and during the total period 195 lectures were delivered, attended aggregately by 6,200 children.

Many more schools and classes would, I am certain, have gladly participated but for the difficulty of allotting them dates. As things stood it was not possible to arrange for more than two or three lectures to each class during a school term; that is to say, each class could not ordinarily be asked to visit the Museum more than four or six times during the year. The intervals between these visits were necessarily long—as much as five or six weeks in some instances. This, however, could not be helped, and the original idea being that the Guide Lecturer was not required to *teach* natural history as much as to supplement the school nature study curriculum (it was proposed to introduce), so as to lighten the burden of the school teacher and to rouse and maintain enthusiasm and interest among his pupils, this arrangement, though leaving much to be desired, was considered satisfactory as a beginning.

Before fixing and launching out on any definite programme of lectures, it was considered desirable to acquaint the pupils with the subject of animal life in general, giving a broad outline of its web of inter-relationships and inter-dependences, and of the complex effects of its diverse environments; to hint on the broadest possible lines on the marvels to be seen in the animate world by those who care to look for them so as to create in the pupils an interest and a thirst for knowledge which would provoke further enquiry and independent research on their part.

On these lines five lectures dealing with Vertebrate animal life, i.e., Mammals, Birds, Reptiles, Amphibians and Fishes, were prepared. Museum specimens, models and specially prepared lantern slides were used to illustrate these talks, each of which lasted forty-five minutes. Every class had to go through all the five lectures in rotation and the preparation of a similar series on Invertebrate life was being contemplated when the scheme had to be abandoned.

Considerable interest and enthusiasm were displayed by most of the classes, who as a rule showed great eagerness to attend the demonstrations. The Head Mistress of an A.-V. Girls' School at Thana told me that her pupils were so keen on coming to the Museum, inspite of the distance (an hour's run by train), that she

found it difficult to leave some of her classes out of the scheme owing to their being insufficiently grounded in English to follow the lectures by themselves. These latter had heard about the demonstrations from their friends in the higher classes and were clamouring to be taken to the Museum likewise!

Besides the school programme, a number of lectures of a more advanced nature were arranged for school teachers of the Bombay Education Society, the Bombay Teachers' Union and Girl Guide organizations. In addition, a number of teachers were supplied with information and assistance regarding the teaching of various Nature subjects in their respective schools; copies of my notes of the Museum lectures were also placed at their disposal and articles dealing with Nature Study were contributed to various Scout Magazines.

The most interesting phase of our activities, however, was in connection with blind children. By previous appointments with the Principal, 40 boys of the Victoria Jubilee School for the Blind were on two occasions brought to the Museum lecture room where simple talks in Urdu were given to them concerning animal life in general. A number of stuffed animals and other exhibits were given to the boys which they could handle and feel. Among other objects they were given the skull of a tiger and one of a horse to illustrate the difference in dentition, adapted to different modes of life and representing the carnivorous and herbivorous type of mammals. The boys passed their fingers over the skulls and teeth, examined them thoroughly and seemed highly pleased and interested. Some time after the tiger skull had been scrutinized and the significance and utility of its special type of dentition explained, a cat's skull was handed round and one little mite immediately announced that it belonged to some flesh-eating animal of the same type, probably a cat!

Lectures to blind boys was a phase of our activity which we were anxious to develop as much as possible, and we were hoping before long to be able to prepare a series of exhibits for the special use of the blind in illustrating our nature talks to them. Mr. F. V. Evans, a constant benefactor of the Society, kindly sent in a donation of Rs. 100 to be devoted particularly to the preparation of exhibits for blind children, but for the time being our activities in regard to the teaching of nature study, which were started with so much thought and deliberation have had to be discontinued for want of the necessary means to carry on.

The Committee of the Society realizing the situation went so far out of their way as to suggest to Government that they should pay only half of the present Guide Lecturer's salary and expenses while the Society would defray the other half, utilizing half his time for their own work in return. Government, however, could only consent to pay a quarter provided the Bombay Municipality contributed a like amount and shared in the benefits of the scheme. For financial reasons the Municipal Schools Committee have turned the proposal down, and for the present therefore the Nature Study programme, much to our sorrow, has had to be suspended.

THE STUDY OF INDIAN BIRDS

BY

HUGH WHISTLER, M.B.O.U.

Part I

THE ORIGIN OF BIRDS

(*With two plates*)

It is a wise biographer who prefaces his work with an introductory chapter in which he traces the history of the family from which his hero springs ; the family in question may be obscure, of mean origin, unknown, or of a fame which is best not dragged into the light of print ; or its history may be such as to confer splendour on the country that gave it birth. Yet, good or bad the biographer spares a little space to set it down for he knows that his readers are sure to ask the origin of their hero. Sprung from the gutter they acclaim him the greater marvel—the architect of his own fortunes ; scion of a lordly line they see his prowess in his ancestry, his brain a heritage of birth and breeding. Good or bad his origin must be revealed or the biography is stigmatised as incomplete.

Thus it is that before we start to examine the various general aspects of bird life, we must spare a few pages to study the origin and pedigree of the great class Aves. There must have been some beginning to the order. Either it sprang at the moment of creation ready made, complete in all its orders and families, its genera, its species and subspecies ; or it grew stage by stage evolving slowly through the ages, acted on by the myriad influences of the world, affected by the other items of the universe, affecting them in its turn.

There are those who hold to the literal interpretation of the words of the first chapter of Genesis. 'And God said, let the waters bring forth abundantly the moving creature that hath life, and fowl that may fly above the earth in the open firmament of heaven. And God created great whales, and every living thing that moveth, which the waters brought forth abundantly, after their kind, and every winged fowl after his kind: and God saw that it was good. And God blessed them, saying, Be fruitful, and multiply, and fill the waters in the seas, and let fowl multiply on the earth.' In this literal belief there is no room for an account of the origin of bird-life as we see it existing now ; it sprang into being complete ; it stands to-day as it stood in the beginning of the world, differing only in the presence then of the forms which have since become extinct.

There are difficulties in the way of so literal a belief. They need not be discussed, but I will assume that my readers will hold it no impiety if I affirm my ability to reconcile a firm belief in the divine origin of creation with all that modern science teaches of Evolution

and the history of the world. Trace back the pedigree of the humming-bird to the protoplasm, and to bring the protoplasm into being remains as wonderful an act of creation as to make the humming-bird.

Science then teaches us that the class Aves did not start as we see it now, outnumbering all the other classes of vertebrates with a roll call of about 19,000 species. But as a tree starts from a single seed, grows a stem which puts forth boughs, which in their turn produce branches and innumerable twigs and leaves, so these 19,000 species are the leaves of a great tree which has sprung from a humble origin—a tree whose boughs are the great vertebrate groups. The illustration is not quite exact for the leaves of the different boughs are not all of one pattern as in a tree of the forest, but the simile expresses the idea intelligibly enough.

The animal kingdom is divided into two classes, vertebrates and invertebrates, distinguished respectively by the possession or non-possession of an internal skeleton built up on a backbone and skull. (Vertebra= one of the segmented portions of the spinal column or backbone.)

The vertebrates fall naturally into five classes: mammals, birds, reptiles, amphibia and fishes. The number of species in the classes are usually given as follows, mammals between 7,000 and 8,000, birds about 19,000, reptiles between 3,000 and 4,000, amphibia 1,000, fishes between 8,000 and 9,000.

It will be noticed that the birds and the fishes are numerically the strongest groups. This is probaly due to the fact that they are capable of travelling in those media, the air and the water, that offer the least barrier to their distribution—an explanation which is in itself an important corroboration of the theory of evolution.

Descent and affinity are merely different aspects of the same fact; so in our search for the origin and descent of birds we are at once advised to look for the affinities of birds. It will be a matter of surprise to many to learn that among the five classes of vertebrates the birds show the greatest affinity to the reptiles.

Such a statement needs substantiation. The cold-blooded ugly lizard half torpid amongst the rocks seems as far removed as possible from the active beautiful bird singing on the boughs and careering lightly through the skies. Bird and reptile seem at least as far apart as bird and mammal, fish and amphibian.

There is abundant proof of the relationsip (in the widest of terms be it remembered) between bird and reptile. The proof may be found in the anatomical resemblances between the two classes and again in the similarities of their early development. And confirmation is found when we turn to the pedigree of the birds and study the earliest forms known to us only from the evidence of fossils.

These three basis of proof need to be examined in some detail.

First to turn to the evidence of the anatomical resemblances.

Proof of the reptilian origin and character of birds—and I put it in this phrase as the reptile is indubitably the older and parent form from which the bird has evolved—may be found not only in the skeleton but in the brain and the vascular and urogenital systems.

The evidence of the latter is too technical to be dealt with fully here but most of us have a general acquaintance with the skeleton of a bird; so the main point of the skeletal resemblance between bird and lizard may be briefly indicated.

One of the most important points is the method of articulating the skull with the backbone. In the mammals the skull connects with the first vertebra through two occipital condyles; in the reptiles and birds the connection is by means of a single condyle, that is, a rounded boss of bone projecting from the floor of the skull below the aperture through which the spinal cord joins the brain.

In the mammal the lower jaw or mandible consists of a single bone. In the bird it is as in the reptile a complex structure made up of four or six bones on each side.

In the bird and in the reptile the connection between the skull and the lower jaw is by means of an anvil-shaped bone, the quadrate which is not found amongst mammals. The quadrate joins that bone of the cranium which is known as the squamosal; in the mammal the lower mandible articulates directly on the squamosal without the intervention of a quadrate bone, a fact explanatory of the separation of the lower jaw of a mammal from its skull as soon as the flesh and muscles have decayed.

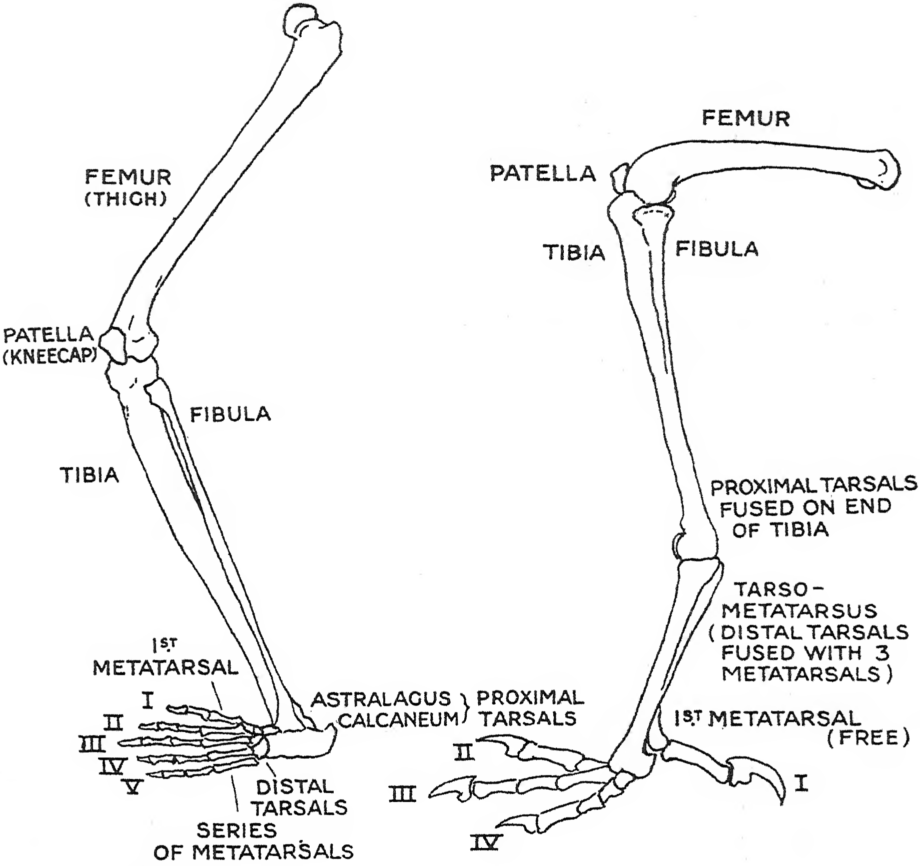
The columella, a delicate rod of bone passing from the drum of the ear to the inner ear is a common character between birds and reptiles and both the classes resemble each other in the general plan of arrangement of the bones of the palate and cranium.

The neck vertebræ of the bird resemble those of the reptile at least in their immature stages, in the possession of free ribs and in the absence of the Epiphyses found in mammals. The Epiphyses are flat discs of bone which fit on to the ends of the vertebra and enable new bone matter to be added in the enclosed space until with the completion of growth the Ephiphysis fuses with the main body of the vertebra.

The hip and shoulder girdles of birds are built on a reptilian model, and this resemblance is again most clearly accentuated in the structure of the hind limb. This is seen in two points, the character of the ankle-joint and the nature of the tarso-metatarsal segment.

In the mammal the ankle-joint works by a hinge between the shank and the uppermost row of ankle-bones; in the bird and the reptile the hinge works between the two rows of ankle-bones. This distinction is very clear in the reptile where the ankle-bones have kept their separate character. In the adult bird there are no separate ankle-bones left and this evidence is only to be found in the embryo and the nestling before the separate bones have fused into the coalesced whole which they become in the adult bird. In the embryonic bird several ankle-bones (tarsals) can be distinguished; in the nestling these have already shrunk to two, one the mallet shaped bone known as the astralagus and the other a flat disc.

The astralagus fits on to the end of the shank supported by a short spur up its front; it soon coalesces, a few weeks after hatching, so completely with the shank that all trace of it is lost.



Comparison of leg of Ape (greatly reduced) and of bird to show the relationship of the bones.

The second bone is applied to the surface of the three tarso-metatarsal bones and coalescing with them completely becomes the top of the 'cannon-bone'. This 'cannon-bone' known anatomically as the tarso-metatarsus and known to us familiarly in the living bird as the scale-covered tarsus consists in its origin of these separate bones; in the nestling bird the division between the three bones is still visible though it has disappeared by the time that the bird is adult. Then the flat disc representing the lower tarsal bones and the three tarso-metatarsals becomes the firm tarsus of the bird with no trace of its composite origin. The hinge between the two rows of the tarsal bones, still so clear in the less developed reptiles, has become an apparent hinge between two long bones in the bird's leg.

It must be clearly understood that the same bones go to the making of the leg of the mammal, the bird and the reptile. The differences merely consist in the different uses made of those bones with corresponding developments and suppressions. Superficially one is apt to consider the bird's leg as differing in structure from the human leg in the possession of an extra joint and the reversal of the direction of the joints. This is not so. All that has happened is that certain bones have been elongated, the instep region has assumed an almost vertical position and the number of bones has been reduced by fusion. The knee joint is hidden amongst the feathers; the ankle-joint appears superficially as a reversed knee since the instep has risen from the base of the toes and become the scale-covered tarsus.

And the proof of all this lies in the immature bird, clear in the embryo, fading slowly in the chick as it progresses to maturity; and in the proof of the changes lies part of the proof of the reptilian origin of the bird—a striking example of that theory of Recapitulation, the fundamental law of biogenesis formulated by Haeckel, which holds that the embryo slowly develops to the adult along the line of the changes that the species has experienced in its evolution; which holds, in the striking popular phrase, that every living creature climbs its own family tree. Some other features may be briefly indicated in which the relationship between bird and mammal may be traced.

To begin with, the blood of a bird is reptilian in character, that is to say it retains the nucleus in the red corpuscle, which is shared by all other lower vertebrates but is lost in the mammals. (How many officials in India have had to forward bloodstains to the Chemical Examiner and await his report as to their being mammalian or otherwise in character.)

The bird's brain is a reptilian brain raised to the highest power of its special development, while the mammalian brain has developed on special lines with new formations.

The eye and the ear of the bird are in their main features merely a further evolution of the peculiar features found in the reptiles and differing in essentials from the same organs in the mammals.

There is one important muscle peculiar to birds and reptiles and found in neither mammals nor amphibians. This is the ambiens muscle which originates on the pelvis and runs along the inner side

of the thigh to end in a long slender tendon which passes obliquely across the knee joint.

The skin of reptiles and birds, as opposed to that of mammals and amphibians, have few glands, with the result that they do not sweat.

But most noticeable of all, the legacy of reptilian scales still persist in the bird. It is patent to all on the tarso-metatarsus of the leg, while the horny covering of the beak is usually considered to be of the same nature; in fact the compound nature of this horny covering, divided clearly into various plates in certain species such as the gannets, petrels and albatrosses, is believed by some investigators to correspond with certain of the horny shields which cover the forepart of the head in snakes and lizards. And this covering is actually shed in the same manner as the 'slough' of reptiles in a few birds such as the Puffin (*Fratercula arctica*)) which sheds the epidermis of its beak after breeding.

But the scales persist in the form in which we least expect to find them, in the very feathers which are usually cited as the chief glory and the most marked characteristic of the class Aves. This is indicated by a microscopical examination first of the development of the scales of the reptile and on the foot of a bird, and of the development of a feather which is perhaps nothing more than a cylindrical fringed scale. They all start as a small protuberance occasioned by an increased growth of the cells of connective tissue in the cutis close to the epidermis; this protuberance is transformed into a cone, the apex of which is directed backwards and gradually assumes a flattened shape. This in the reptile becomes the scale; in the bird it lengthens into the feather-pulp from which grows the down that precedes the permanent feathers. As corroborative evidence of that afforded by the microscope we may cite the feet of such closely allied species as the Pheasant, Blackgrouse, and Ptarmigan where we have a scaled foot and a feathered foot connected by a partly scaled and partly feathered foot, clearly showing how the same basic material can produce either feather or scale.

Finally we find great resemblances in reptiles and birds between their methods of producing their young. In the egg cell of all animals we find the simple typical cell structure, but when mature the egg varies according to its assimilation of reserve materials as a store of nourishment for the embryo during its development. The egg of the mammal however remains attached to its mother during embryonic development and therefore does not require a large yolk, that is, reserve food material.

The eggs of the reptile and of the bird are however separated from the mother and therefore require abundant reserve food material; their mature size is often in consequence very large. Like the reptiles birds are oviparous, but no birds are ovo-viviparous like some reptiles. It must be remembered also that a few very primitive mammals such as Ornithorhynchus, the Duck-billed Platypus, still 'lay eggs' in the popular sense.

The egg of the bird and the reptile are alike in their essentials. In the egg of the goose and the crocodile for instance there is the true ovum or egg cell, known variously as the germinal disc or

blastoderm, from which the formation of the embryo takes place after germination. This is dilated with yolk and is generated in the ovary. All other processes in the formation of the egg take place in the oviduct. In the upper part of the oviduct it encounters the spermatozoa of which one or more enter it and fertilize it. Then it is enclosed in albumen and further down it is covered with the shell-membrane which in the final stage is itself enclosed with, the shell. This outer shell is formed in all birds and many reptiles.

In the egg of both classes the egg-cell after fertilization divides into two daughter cells; these in turn further subdivide and the process continues rapidly until a circular disc of cells is formed, then an important change takes place with the differentiation between groups of cells. The resulting growth need not be detailed here. suffice it to say that the earlier embryonic stages in bird and reptile run on parallel lines until about the sixth day when definitely avian characters emerge in the embryo bird.

In both embryos the membranes known as the amnion and allantois appear at any early stage. The function of the amnion is to enclose the embryo with a fluid to protect it from pressure and injury. The allantois serves as a receptacle for urine and as a respiratory organ. It spreads under the shell of the egg and by means of its blood-vessels absorbs oxygen through the porous shell. When the lungs commence to function the allantois shrivels up and is ultimately cast aside with the broken shell.

Finally both embryonic bird and reptile develop the so-called egg-tooth; this is a small hard point loosely attached to the tip of the upper jaw which drops off the young bird shortly after hatching. It is usually considered as of use in breaking the shell before emergence from the egg.

It remains to check our deductions by examining what relics remain of the ancestry of our present day birds. For obviously if there is any truth in the theory, suggested by the examination of the anatomy and embryology of a bird, that its origin is reptilian the further back we can examine its pedigree the more likely is that to show its connection with the reptile. The evidence of Geology has revealed striking evidence of the descent of other vertebrates; it should also afford evidence of the descent of the bird. And this is exactly what happens.

The first remains of an undoubted fossil bird are referrable to the Jurassic age. It is true that in the Triassic sandstone footprints and their casts have been found of colossal creatures, known collectively as ornithichnites, which were at one time considered to be birds, but the general idea is now that these creatures were Dinosaurian reptiles.

The lithographic stone of Solenhofen in Bavaria belonging to the Jurassic system has however produced two fossils which are birds beyond all doubt. The first specimen was made known to science in 1861 by Andreas Wagner and it may be seen in the South Kensington Museum, It remained unique until 1877 when a second specimen, now in the Berlin Museum, was discovered. It is interesting to note that the discovery of these two specimens was

preceded by the finding in the same formation of a single fossil feather.

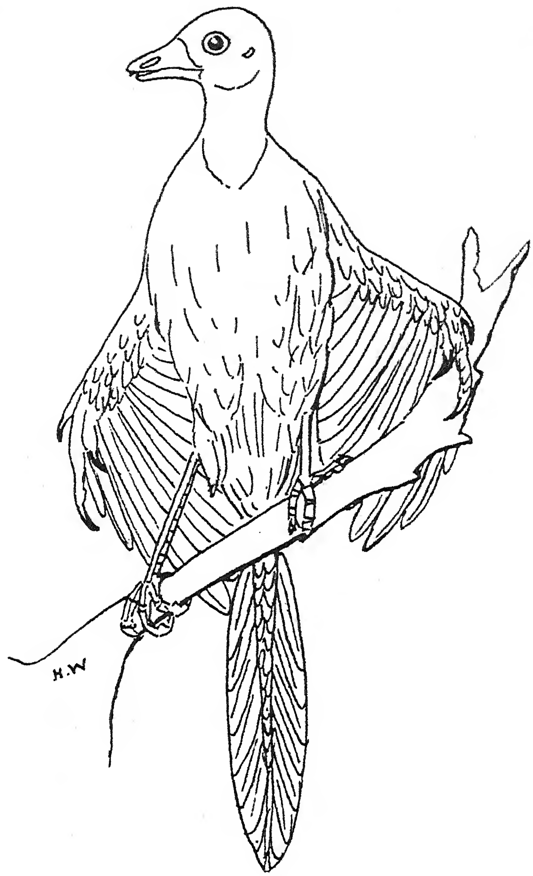
The two specimens were for some time considered to belong to one species named *Archæopteryx lithographica*, but the second is now generally distinguished as *Archæornis siemensi.* Be this as it may, we are able to gain a very distinct impression of this early Jurassic bird as the parts exposed in the two specimens are largely supplementary. For convenience I will speak of both birds under the heading *Archæopteryx*, as the slight differences are unimportant from the view of my remarks.

All of us at one time or another have picked up a dead bird in the earlier stages of decay. The attitude is contorted, the flesh has gone, the dried ligaments hold the bones together, the wing and tail feathers persist though most of the contour feathers have gone. Imagine such a specimen pressed flat like a pressed flower and fossilized. So appear the two examples of *Archæopteryx* which perished in that remote Jurassic age, preserved for us and discovered by the most fortunate of accidents.

Archæopteryx was about the size of a crow. Its general appearance was that of a modern bird, but two peculiar features at once catch the eye. The short blunt bill is furnished with distinct teeth, not the horny processes which we find in the beak of the Merganser and Smew, but real teeth thirteen in the upper jaw and three (and doubtless more) in the lower jaw planted in distinct sockets and obviously reptilian in type. But more remarkable than the beak is the tail. This is a long tapering organ of about twenty-one vertebræ, and from each of the last thirteen to sixteen vertebræ springs a pair of well-developed rectrices or feathers, one on each side of the bone. This tail at once recalls the tail of a lizard or snake, as it were a lizard's tail fringed with feathers, yet is clearly the ancestor and explanation of the tail of the bird. The tail of the living bird consists of five to eight free vertebræ followed by the fusion of others (varying from six to ten) into a bony plate the Pygostyle which supports the fan of tail-feathers. Telescope the long tail of *Archæopteryx* with its fringe of feathers and you have the fan-tail of the bird. This origin of the tail in a number of vertebra each with its opposed pair of feathers explains why all modern birds have a tail consisting of an even number of feathers. No odd central feather is found in any tail.

There are other features in *Archæopteryx* which indicate its reptilian affinities, indeed so marked are these that some would hold it more reptile than bird. Chief of these are the abdominal ribs—subcutaneous ossifications unconnected with the true skeleton which run across the lower surface of the abdomen. They are represented in the crocodile and some other reptiles, but are not found in mammals or modern birds which have the abdomen unprotected below.

Then the wing is very suggestive. This shows two primitive features; the first that the carpals or bones of the wrist and metacarpals or bones of the palm are still separate and have not fused to make the stiff hand of the bird as we know it to-day. This separation of the bones is still indicated in the embryonic and very



Hypothetical Restoration of *Archæopteryx lithographica*

young bird but disappears when ossification is complete. The second feature is the difference between the digits of *Archæopteryx* and the digits of the modern bird. The three digits in the fossil, which as indicated above were free and not fused into a solid structure, bear each a claw and the third digit had as many as four phalanges or separate segments. In the modern bird the third digit has only one phalanx.

In the modern bird the claws are found only on the first and second digits; their persistence varies; in some species they are only found in the embryo, in others one claw is found; in the ducks and birds-of-prey traces are found throughout life. Yet links are found between the condition of the modern bird and the condition in *Archæopteryx* in two directions. A vestigial claw has been found on the third digit in the young Ostrich and in young Penguins while in the young Hoatzin (*Opisthocomus*) the claws are of considerable size and still function. A paragraph must here be devoted to that strange bird the Hoatzin (*Opisthocomus cristatus*) which is of such importance in the phylogenetic study of birds. It is a native of Tropical South America and may be roughly described as about the shape and size of a Grey Hornbill, with a strong somewhat pheasant-like beak and a long pendant crest of loose feathers. It is considered to be a very archaic form of bird with affinities to the galline birds though much closer than them to the ancestral stock. It is entirely arboreal living in bands in the tree growth over streams and lakes. Interest centres on the chick.

The nest is a rough structure of sticks built in the boughs of a tree overhanging the water. Soon after hatching the young leave the nest and spend their time climbing about the boughs of the tree, using not only the beak and feet parrot-fashion but also using the wings, which at this stage have the 'hand' relatively longer than in the adult and bear large claws on the first and second digits. This hand with its clawed fingers is still able to sustain a grip on the boughs, and in the interests of its free play the outermost quills and their coverts are arrested in development until the inner primaries have grown sufficiently long to enable the bird to recover itself in falling. A further peculiarity of this precocious nestling is that if it falls into the water beneath the tree it is perfectly at home swimming to some drooping branch up which it climbs again. Becoming adult the Hoatzin loses the special characteristics of the wing and their use.

That this free hand and clawed digits are a survival from the days of *Archæopteryx* is very clear, and a vestige of it may be seen any day in the fowl-yard. If a small chick a few days old is examined, just as the wing quills are developing, one will find the first digit bears a weak but plainly discernible claw and that the growth of the outer quills is retarded as it was in the æons ago when that finger and claw could be used; while a similar retarding of the inner secondaries is said to point to an ancestral patagium or parachute fold between the elbow and the body still traceable in the embryo Ostrich.

Having found *Archæopteryx* we naturally desire to bridge the long ages and stages which separate it from the bird of to-day.

Unfortunately the record is far from complete. It is not until the Cretaceous period that we again meet with the fossilized remains of birds.

Two forms stand out in this period conspicuous through the importance of their preservation and remains. They are known as *Ichthyornis* and *Hesperornis* and both are found in the upper Cretaceous shales of Kansas. Both these birds very definitely belong to the modern bird type except that the jaws still bear teeth. They are regarded as representing an early specialized offshoot from the common ancestral type of the two great surviving orders the Ratitæ and Carinatæ, now perhaps more rightly designated the Palæognathæ and Neognathæ. Between themselves they are very distinct and this suggests that there was already a very extensive bird-fauna in existence. Both forms may be briefly described.

Hesperornis was a flightless aquatic bird about six feet long from the tip of the bill to the outstretched toes and it must have greatly resembled a modern diver or grebe ; it had rudimentary wings and no keel to the breastbone. The teeth were planted in grooves in both jaws. That it was specialized in the direction of swimming is denoted by the pelvic girdle which resembles that of the divers, while the knee joint resembles that of the grebes. Its chief feature however is the patella or knee-cap of enormous size and curious shape which rendered the bird incapable of straightening the leg at the knee joint. The patella was a point of attachment for the swimming muscles. The bird was a swimmer incapable of anything else, and no more highly specialized form is known.

Icthyornis was considerably smaller. It was delicately built with well developed wings and a keel on the breast bone. The teeth are in grooves and the vertebræ are biconcave both reptilian characters. With these exceptions it is a very modern looking bird and it is generally considered as the ancestral type of the Steganopodes, that is the order containing the Gannets, Cormorants, Pelicans and allied forms.

After *Hesperornis* and *Ichthyornis* the record becomes confused. Fossil remains have been recovered and named in numbers, but many thought to belong to birds have since been proved to belong to reptilian forms ; others are certainly avian but they are too fragmentary to supply much information. Among the Tertiary birds there are many different to those now living but they are associated with nearly all the principal forms that still exist. There is a gradual though confused record of progress.

To sum up, the avifauna of to-day is clearly descended from an avifauna present in Cretaceous times ; this differs chiefly in the presence of teeth, a character clearly inherited from a previous Jurassic fauna in which *Archæopteryx* affords a complete blending of bird and reptile.

Earlier than this the line is lost ; the remoter ancestor is merely ground for speculation.

This remoter ancestor was not necessarily able to fly at all. It was not amongst the Pterosaurs, the strange 'flying dragon' which immediately springs to the mind as a possible ancestor. The

Pterosaur stock has many points in common with the bird, long hollow bones, a fusion of dorsal vertebræ to make the body rigid for the wings to play upon, and traces of a keel on the breast bone to support the wing muscles. But it is separated from it by important differences in the hip girdle and the vertebral column, and by the absence of a clavical in the shoulder-girdle while the wing is so entirely different in structure as to indicate a separate line of development and approach to their common purpose. The Pterosaur's wing is a Patagium-wing, that is to say composed of a membrane similar to that of a bat, attached to an enormously elongated 'little finger' and continued back to the hind legs and tail. The wings of the Pterodactyl and the bird doubtless evolved from a common habit of using a fold of skin on the forelimb as a parachute; but their development progressed in different directions and neither evolved from the other.

There is more probability in the theory that the remote ancestor of our quest was of Dinosaur stock, but there have been various and conflicting theories as to the actual class from which it sprang. The most recent view is that of Heilmann who examines the claims of Pterosaurs, Predentates, Cœlurosaurs, and Pseudosuchians at careful length and finally decides that the Pseudosuchians alone fulfil all the requirements of the hypothetical ancestor's anatomical requirements, that is, to allow the Pseudosuchian stock to develop into *Archæopteryx* and through it into the bird of to-day.

In the course of time he suggests that these reptiles raised the forepart of their body from the ground with increased frequency balancing with their tails to assume a bipedal gait, exactly as to-day we may see Frilled Lizards run at great speed. Their hind limbs slowly were adapted to this manner of walking. The erect reptile then adopted an arboreal life, climbing about the boughs of trees, leaping from one to another. The first toe gradually changed into a hind toe to grasp the branches, while the hind leg having left its reptilian position for walking is held close to the body while leaping, not spread in the manner of other creatures that have developed flying. The developing parachute then is confined to the forelimbs and tail, while the forelimb is still used for climbing. The parachute consists of scales, but these slowly develop into feathers, which at length encroach over the whole surface of the head and body encouraged and required by the increasing temperature of an organism on which increasing activity makes greater and greater demands.

The picture is no doubt a fanciful one; but so clear is it that the bird of to-day is descended from reptilian stock that something of the kind must have happened, and the road by which the bird has grown and travelled is dimly indicated in the records of the past. Future discoveries may make these records fuller—till then we must content ourseves with hypotheses such as the above.

In discussing this question of the ancestry of modern birds I should have liked to quote some evidence from Indian sources. Unfortunately however but few remains of fossil-birds have been discovered in India and of these so far as I am aware none are older than the Pliocene.

Apart from the Pleistocene cave deposits of Karnul which have yielded a small number of remains all referred to existing Indian species, remains of birds have only been found in the Upper Sub-Himalayan Siwaliks and their number is still very small. These are all Pliocene and with two exceptions were identified by Lydekker as belonging to genera still found in India such as Pelican, Cormorant and Adjutant. The two exceptions are interesting.

They belong according to Lydekker to the Ratitæ. One of them was a true Ostrich (*Struthio asiaticus*) apparently closely allied to the existing Ostrich (*S. camelus*) of Africa and Arabia but with relatively shorter and stouter cervical vertebra and somewhat thicker metacarpals. The other was a three-toed form related to the Emeu (*Casuarius*) and approximately of the same dimensions. For this Lydekker proposed a new genus and named the bird *Hypselornis sivalensis*.

Finally to those who desire to read more deeply the evidence regarding the origin of birds, I can recommend the following books to which I am deeply indebted in this and the following chapters.

A Dictionary of Birds, by Alfred Newton, London, 1893–1896 (Adam & Charles Black).

A History of Birds, by W. P. Pycraft, London, 1910 (Methuen & Co.)

The Biology of Birds, by J. A. Thompson, London, 1923 (Sedgwick and Jackson).

The Origin of Birds, by G. Heilmann, London, 1926 (H. F. and G. Witherby).

(*To be continued*)

REVIEWS

1. BIG GAME SHOOTING IN THE INDIAN EMPIRE.

(By Lieutenant-Colonel C. H. Stockley, D.S.O., O.B.E., M.C., F.R.G.S., F.Z.S. The Oxford University Press, 1928, 200 pages, 63 illustrations. Price 18*s*. net).

Quite a number of books on Indian Big Game shooting have been published in the last few years, and now we have a book by Colonel Stockley dealing with a wider range than any of these.

Some forty years ago General Kinloch wrote a book on Indian Big Game Shooting. The book now before us has been written with the object of fulfilling the want of a work on somewhat similar lines but at a price within the reach of the ordinary soldier-sportsman of India.

In the 'General and Introductory' chapter the author writes much that is sound as to Game Preservation, and we agree with him that the crux of the whole matter is the elimination of profit by sale of meat, hides, horns, and trophies generally. There is a trade in shed horns which is legitimate but it should be feasible to legislate as to the other items. 'Stop the demand and the supply will cease,' says the author, and that indeed goes a very long way towards efficient Game Preservation.

A well deserved tribute is paid to the Forest Officers, throughout the country, to whose courtesy and assistance we sportsmen in India owe so much. The closing paragraph contains advice which all keen sportsmen in this country should endeavour to follow, and that is to aspire to see and shoot (or photograph ?) as many species as possible. The author has shot thirty-six species out of the fifty-six he describes, but some of these are not usually classed as game animals (the author himself remarks as to these) and we would, for the information of those who wish to follow the advice we comment upon, remark that the number of species to be obtained by a sportsman during his time in India may be said to be thirty-nine.

In 'The Selection of a Shooting Ground' condensed information is given as to twenty-four provinces or districts. The cost of a shooting trip of two or three months duration is correctly stated. The chapter on Himalayan shooting contains much useful information and advice. One feels there is more to be said, but the author has had to condense, and to omit, in order to keep the price of the volume within a desirable limit. The difficulty of saying enough and not too much is one which must have caused Colonel Stockley much thought. The estimate of cost for Kashmir is in accordance with our own experience in recent years.

The selection of a weapon is discussed at length, the choice falling upon a ·425 H. V. rifle and a ·318, the ·280 being classed with it as equally efficient. The ·400 double is the smallest bore we can agree to for heavy and dangerous game (a ·470, which need not weigh over 10½ lbs. is a preferable weapon). The ·318 we agree to

but *not* the ·280, which we would personally avoid. The author properly remarks 'I do not recommend a novice to start shooting in thick stuff with a ·280 Ross.' To that we would add that anyone novice or expert, is bound to come to grief—and that pretty soon—should he pursue dangerous game with such a weapon. We do not agree that 'ball and shot' guns are ideal weapons for tiger. These weapons will not ordinarily stop a charging tiger. The summing up of the author is right—omitting the ·280. But make the ·400 a ·470 and—once more we stress the point—it is not novice only who should not go into heavy jungle after dangerous game with a light magazine rifle. 'For the hills a rifle should be fitted with a sling', for the plains also, we say.

The chapters on 'Outfit', 'Marching and Camping', 'Searching for Game', 'The Stalk', 'Tracking', 'Beating', 'Sitting up', 'The Shot', and 'Skinning and Preserving Trophies', all contain much that is useful which, however, could with advantage have been given in more detail in some respects. Fifteen lbs. of flour is a very short allowance for two months but no doubt it is meant that this is supplemented by atta in form of chupattis.

To the list of medicines: calomel, iodine tincture, oxide of zinc, adhesive plaster (wide and narrow), eye-bath cup, zinc powder to make lotion for sore eyes, safety pins, clinical thermometer, and a copy of Moore's *Medicine for India* might be added. In the plains a ·22 rifle certainly should be taken. The sun hat, of whatever type it may be, is like no object to be seen in the jungle and should be camouflaged when one is after game by leaves, etc. A whistle is sufficiently powerful for purpose of halting a beat as a warning in case of a wounded animal and red and white flags could only be seen by a few. A signal horn which can be clearly heard at a long distance, is essential.

Those who have done much sitting up will not agree with the author that that there is little trial of the hunter's skill or endurance. There is much technique only to be learned by experience, and on many occasions great endurance is called for. Sitting up is, of course, only allowable for tiger and panther.

The advice of Colonel Stockley is that 'sitting up' on the ground whenever possible is the best method for tiger and leopard. The advice is quite right as to leopard but we do not advocate the same thing for tiger. They have little if any more sense of smell than panther—though we have both seen and heard them very obviously using their noses when approaching a 'kill'—but are different in character, more intelligent. There are not many sportsmen who are likely to agree with the author in this matter. Given suitable soil and surroundings the pit method is undoubtedly the best method of concealment and more sure in results than any other.

The chapter on skinning and preserving is good. It might have been stated that all blood and dirt stains should be washed off before the animal is skinned.

The photographs in the book are mostly very good and—an important point—it is evident that it is the habit of the author to always take care to properly pose the body of the animal. Too often this is not done and the picture suffers in consequence.

A word in favour of the panther! Several recent authors have styled this sporting beast as vermin, to be killed by any method, and our author follows suit. Would they advocate the use of poison? We think the panther a very sporting animal. Fierce at all times and indomitable when wounded, he will on very few occasions omit to charge when followed up.

To revert to the chapter on beating. 'Astride a branch of a tree' is recommended as a post for a sportsman in a beat. This is quite right in a way, as choice of position is not dictated by consideration of possibility of tying a machan. But it should be made clear that the position should not be 'astride' a branch, but standing on a branch with a rope round the waist and the tree trunk. In such a position it is possible to cover a much wider circle and there is no need to think of balance. A couple of gimlets should be carried to form convenient pegs for water bottle, etc., and a length of cord for pulling up and lowering the rifle. We mention all the above as an instance to point the observation, already made, that throughout the book more detail is required in some respects. Those with experience have learnt all these things; but the book is for sportsmen beginning to take up shikar rather than for those with full experience.

The volume is well designed and produced and the author is to be congratulated on having published a work which will be a sufficient guide to Big Game Shooting in the Indian Empire to those who have not the means to purchase the various works dealing with particular areas.

R.B.

2. A CRITICAL REVISION OF THE GENUS *ARISTIDA*, being a preliminary study and an introduction to the Monograph. By J. Th. Henrard in Mededeelingen van s'Rijks Herbarium, Leiden, No. 54 (1926), pp. 1-220, and No. 54 A (1927) pp. 221-464, Leiden. Firma P. W. M. Trap.

The two volumes which have appeared so far are only a preliminary study to a complete monograph on the Genus *Aristida*. In this study the author deals with the literature studied and the results of the critical examination of the types. In addition, the new species found in herbaria are being included. In every case of old species the original description is reproduced word for word and in that language in which it was published. This is a great advantage to botanists in general but especially to those who cannot boast of a large private library or have not even the ordinary facilities of consulting public libraries. Every worker has thus the luxury of forming his own independent opinion on many questions of taxonomy. The study is based entirely on material preserved in herbaria, as the author found it impossible to make observations on material under cultivation. This is to be regretted as in all probability it would have thrown light on several critical grasses which, in the author's conviction are hybrids between different species of *Aristida* which are not easy to recognize in dried species. We quite agree with him when he says that field work alone is not

enough to clear up the different varieties of a species or the differences between allied species. 'So far as I have cultivated different grasses,' he says, 'I have found that many characters used by agrostologists are absolutely constant, but it is a fact that many varieties described in our manuals are but products of local conditions. Such plants were called by botanists "forma", but such a delimitation is nonsense.' It is always gratifying to hear an authority expressing in unmistakable terms an opinion which all along you had carried about but which you had not the courage to mention in public.

E.B.

3. A GARDEN BOOK FOR MALAYA. By Kathleen Gough, London. H. F. & G. Witherby, 1928, 422 pages, price, 16*s*. net.

The origin of this book can be traced to a series of gardening articles for the *Malay Mail* under the nom-de-plume of 'Quisqualis'. The volume before us is not a mere compilation. The authoress has tried to offer the results of her own experience of gardening in Malaya over a number of years. Practically all her experience was gained in her own garden at Kajang, Selangor. To this she has added the knowledge gained by professional training and practical garden work undertaken when away in England during the war.

Miss Gough first introduces the reader to the local conditions of gardening in Malaya, dealing with the climate and soils. Though describing distinctly local conditions this chapter contains many practical hints for the gardener in India. The same applies to several other chapters which treat of garden practice, just because the authoress always enlivens her treatise with personal observations. A dozen chapters or so deal successfully with special groups of plants, and it is just this part of the book that will be most welcome to the Indian gardener. Some very practical chapters on insect and animal pests, plant diseases and their remedies make the book a very useful guide to gardening not only in Malaya but in the tropics generally.

The last chapter on 'Wild Plants and their Introduction to our Gardens' should convince our gardeners, that there is no more satisfactory or more interesting gardening operation than the successful introduction of an attractive wild plant, an operation which is only too little known in this country.

E.B.

4. POPULAR HANDBOOK OF INDIAN BIRDS. By Hugh Whistler, F.L.S., F.Z.S. Illustrated. London: Gurney and Jackson. Price 15*s*. net.

The attempt to write a book on the common birds of India is one which had never been made until of very recent years. Long ago 'Eha' wrote most charming books on various aspects of Indian life, ornithological amongst others, but he never dealt with any particular class of animals as a whole. More recently Finn and Dewar have also written many books, the former several most

comprehensive works on birds, every volume teeming with information, the result of his keen powers of observation. Yet even he was more or less daunted at the thought of tackling so comprehensive yet vague a subject as the Common Birds of India. Fletcher and Inglis in 1924 published a volume entitled *Birds of an Indian Garden* but this excellent book only deals with a very few species of birds, although it deals with these very fully.

Mr. W. S. Millard has for many years been anxious to bring out a book which shall really be worthy of the title above mentioned and it is owing to his generosity and the help of Mr. F. Mitchell and Sir George Lowndes that the present volume owes its birth at a price quite incommensurate with the immense labour it has entailed and its scientific and popular value.

The work has been entrusted to Mr. Hugh Whistler, a gentleman already well known, not only to the members of the Bombay Natural History Society, but to many ornithologists of many countries. His articles in the *Bombay Journal* have proved him to be a naturalist of no mean order, a very close observer and an interesting recorder of what he sees. The present volume is, of course, something much more ambitious than any of his previous work but it is only fair to say that his reputation will certainly not suffer in consequence of its publication. We can congratulate both Mr. Millard and Mr. Whistler on having succeeded in bringing out a book on the common birds of India far in advance of anything previously attempted.

Scientific books containing a certain amount of information on the biology of the bird are available to the scientific student but these are of necessity bulky and contain much that is not required by the field naturalist or by the mere bird-lover. Both of these classes of readers will, we believe, find in Mr. Whistler's volume all that they require and we are sure that the visitor to India who desires to know the names of the birds he sees, together with further information about their habits, will find this book of the greatest help to him in every way.

If there is one failing which we feel we cannot pass over without comment, it is the fact that it deals so very largely, one might almost say exclusively, with the birds of North-West and Western India. It is perhaps excusable that an author whose knowledge of bird life is confined to one portion of so vast an area as the Indian Empire should be dominated by his knowledge of the birds of that particular area. Mr. Whistler has not been altogether successful in realizing that a bird may be one of the common birds of India although it has not been common in those parts of India which have come under his personal observation. We find that whatever order or family he deals with, the great majority of the birds he gives as examples of the common birds are those which are most often met with either in the Punjab, North-West Frontier or Bombay Presidency. The following are simple instances of this tendency. When dealing with the Jungle-fowls, Mr. Whistler selects the Grey Jungle-fowl and omits the Common Red Jungle-fowl. Immediately after this he gives one of the Western Himalayan Kalij Pheasants (*Gennæus leucomelanus*) as a type of the genus instead of the eastern

bird, the Black Kalij Pheasant, with a far greater range of country. Amongst the storks he omits altogether reference to the Adjutant, so common a bird over practically the whole of Eastern India as far south as Madras. These instances could be added to almost *ad infinitum* and it really would appear almost impossible to obtain a volume worthy of so widely embracing a title as that of the 'Common Birds of India,' until we obtained a committee of local authors to edit amongst themselves a work of this nature.

The format of the book is very satisfactory and under each bird the reader will find it easy to obtain the details he requires. The descriptions given of the birds are ample and, whilst not too lengthy, should suffice for easy identification but the author's field notes, admirable in so far as his own observations go, are perhaps not quite so happy when he treats of those outside his own especial area. He must, however, have many times heard the four musical notes of the Himalayan Cuckoo, the first soft and rather high up, the three following much lower. His description of the call 'a dull booming note', would make a reader imagine that to the author the Himalayan Cuckoo was an unknown bird.

Scientifically the work has been very well done though there are certain points in nomenclature with which we do not agree and the comments on classification given in the preface are perhaps unnecessary in a book of this character. If necessary, they should have been given more fully and on better recognized lines. On the other hand, Mr. Whistler has wisely drawn attention to the points on which further information is still required, as well as to the work in Indian ornithology of which so much still remains to be done amongst the Oriental Aves.

The plates, both the coloured and the black and white woodcuts, are by Mr. H. Gronvold and are worthy of that artist, higher praise than which can hardly be given. The general get-up of the book is all that can be desired and the only fault we can find is the excessive weight of the paper used.

A Popular Handbook of Indian Birds is a very useful book, well written, beautifully illustrated and one which we can recommend very heartily to every bird lover and visitor to India.

E. C. S. B.

5. BEAUTIFUL FLOWERS OF KASHMIR By Ethelbert Blatter. S. J., Ph. D., F. L. S., Illustrated by Mrs. G. A. Wathen and Halder Joo Walli. Vol. I. (Publishers: John Bale, Sons and Danielsson, Ltd., 83–91, Great Titchfield Street, London, W. 1. Price, Rs. 14.)

'Beautiful Flowers of Kashmir' is an admirable volume, being both scientific and popular. It will be a valuable companion to visitors to Kashmir as well as an important piece of floristic literature to a botanist on Kashmir's hidden floristic beauties. It is written in a very easy style. Though written especially for the layman, the volume should find a place in the library of every

botanist. It is hoped that the admirable attempt of the author will be followed by other scientists in popularizing other technical subjects.

The keys to species, always a matter of difficulty, are very cleverly done. A glossary in a volume like this is valuable. The two indices should be equally useful both to the layman and to the botanist. The illustrations are accurate and very attractive. The type is clear and the fount used for generic and specific names is suitable. The general get-up of the book is excellent.

We wish that the reference to illustrations had been noted at the end of the names of species instead of at the beginning. The names of the founders of the genera and species should have been in italics to give a contrast to the names of genera and species.

As another volume of the 'Beautiful Flowers of Kashmir' is soon to follow, we shall reserve further remarks for reviewers of that volume. We should not be surprised if this volume ran into a second edition before the last one is out.

T. S. S.

EDITORIAL

Ourselves

An Indian illustrated weekly recently offered its readers a prize for the best suggestions indicating how the paper could be generally improved and made more interesting. The competition was a great success. We cannot at the moment recall the number of entries, but we are told that the editor's post bag so overflowed with 'ideas' that the selection of the prize-winner was a matter of difficulty. We cannot follow the example of our enterprising contemporary, but, with similar motives in view we would welcome the happy discovery of a medium for arousing a similar response from the readers of this publication. A member from Burma recently expressed his views on our Journal from what he believed was the ordinary readers' standpoint. His letter was welcome. It revealed an interest in our work and a desire for helpful co-operation which, if more generally followed, would, we believe, be mutually beneficial. It would help us to produce a Journal more acceptable to the majority of its readers and would free the Editors from the pitfalls of 'many a blunder and foolish notion'. 'For people living away from Bombay,' wrote our critic, 'the main benefit received from the Society is the Journal; and I (and possibly other members) am so ignorant that 50 per cent of the matter you publish conveys nothing to me. No one would suggest that you should debase the standard of the Journal; the alternative is to educate members and *potential members* up to it.' This is an old and long-standing grievance which we have honestly endeavoured in recent years to redress. Our present issue contains five purely scientific papers against nine popular articles, intended expressly for the general reader and this excludes the Miscellaneous Notes which are usually found interesting and attractive. Mr. Whistler's article on 'The Study of Indian Birds' and Mr. McCann's serial on the 'Study of Plant Life' have been written at the suggestion of the Editors for the purpose of assisting readers who may be inclined to interest themselves in the study of these subjects. We have in preparation a serial on Indian Flowering Trees. This will be illustrated in colour and will, we hope, find favour amongst our readers. Apart from this the large number of illustrations and plates we are issuing at present with each number, whose cost incidentally keeps us awake o'nights, will indicate our desire to offer our readers an acceptable equivalent in return for the support they give to the Society. The scientific standard of the Journal must be however rigidly maintained. Our readers will agree to this when they realize that it represents the more serious side of the Society's work—one of the main objects of its existence. How far this objective has been realized and how great a contribution the Society has made to the advancement of Biological research in the Oriental Region, the thirty odd volumes of its Journal will

reveal. Without the support and the assistance of members, who though not expressly interested in the scientific side of this publication, have nevertheless contributed financially to its production, the great work that the Society has done and is now doing could not have been achieved.

In the present issue of the Journal we have introduced at the suggestion of an old and valued friend of the Society a new feature—a page or two of answers to questions, received during the last few months—questions which are of general interest and which may incidentally help to strengthen the contact between ourselves and our readers. Our daily correspondence is not only large but infinitely varied. The reading of it produces feelings as diverse as the changing colours of our pet Chamæleon who regards us with a contemplative eye from his perch opposite our table. We register joy, repentance, sorrow and occasionally a praiseworthy esteem for ourselves. Among other matters of routine we are called upon to settle bets, to clinch arguments and to assist cross-word enthusiasts in distress! Occasionally we are faced with problems of an intriguing nature: 'What is the name of a blue fish I saw in the Red Sea?' This is a classic example. But very often we receive questions of general interest. A selection of these we propose to publish in our correspondence page, prefixed with the initials of the sender. There are many questions which would elicit we believe more complete information by their ventilation in the pages of the Journal. The problems connected with the introduction of legislation for the protection of Monitor Lizards in Bengal is an instance in point. What is the normal food of the various species of Monitor Lizards? At what time of the year do they breed? How large do they grow before they attain maturity?

Protection of Monitor Lizards

The action of the Bengal Government in placing a ban on the destruction of these lizards has been the subject of congratulation and, on the other hand, of protest from those interested in the trade in Lizard skins. Further information on the points we have raised would be instrumental in the settlement of a question which financially affects a not inconsiderable number of people in Bengal.

The Government notification refers to these lizards as Iguanas (vern. *Go-shap*). The answer to a question raised in our correspondence page in the present number may be helpful in removing the misconception that Iguanas are found in India. The vernacular term *Go-shap* is again commonly used for a number of lizards not intended to be protected under the terms of the notification. Four species of Monitor Lizards occur in Bengal:—The Common Monitor (*Varanus bengalensis*), generally distributed throughout India, the Water Monitor (*V. savator*), mainly aquatic in habit, the Yellow Monitor (*V. flavescens*) and the Clouded Monitor (*V. nebulosus*), an uncommon species. The Yellow, the Common and the Water Monitors mainly furnish the demands of the trade in lizard skins. In view of the interests involved it is too much to hope that

legislation for their protection could be introduced without protest from the trade.

As a plea for their protection, it has been advanced that these lizards are largely instrumental in destroying snakes, rats and other vermin. On the other hand it has been pointed out that Monitor Lizards—the Water Monitor for example—are destructive to poultry, fishes and are in fact a positive nuisance to villagers in the Sunderbans, while their reputed effectiveness as an agent in the destruction of snakes is largely hypothetical. In view of the fact that there is very little known about the normal food of the Water Monitor, the contention would be difficult to positively refute. Observation has shown that the Water Monitor is very partial to birds' eggs. A Water Monitor kept in the New York Zoo would take eight to ten hens' eggs at a meal, swallowing them entire with astonishing rapidity. It has been observed eating turtles' eggs, and it may be reasonably assumed that it would also eat the eggs of other reptiles. Whether live snakes, harmless or otherwise, form a considerable portion of its diet is largely a matter of conjecture. Experiments have shown that the Common Monitor succumbs to the venom of a cobra. Two experiments recorded by Fayrer indicate that Monitor Lizards die after being bitten by this snake, one individual surviving for 28 hours and the other for a slightly shorter time. A 14-foot king cobra was recently killed in Burma while swallowing a 4′ 6″ Water Monitor, and a note in our Journal records one being taken from the stomach of a Python. It is apparent that these lizards occasionally form the prey of large snakes and it is equally probable, from the omnivorous nature of their diet, that they would not be above attacking and devouring any snakes which could be readily overcome. The Common Monitor feeds to a large extent on small mammals, young birds and their eggs. We know from experience that they can be very destructive in a poultry yard. It is on the other hand an excellent ratter destroying large numbers of field rats and must in consequence have a distinct economic value in agricultural districts. This alone would afford a plea for its protection.

The effective provision of a close season for particular periods of the year would be a matter of difficulty, unless efficient means were also introduced to prevent the possibility and the probability of the reservation for sale at a more convenient period of skins secured during the 'close time'?

It has also been suggested that a size limit should be imposed and that no lizards should be killed below a stated size. For the Water Monitor and the Clouded Monitor the limit suggested is 4 and 3 feet respectively. For the Common Monitor and the Yellow Monitor the limit proposed is 2 feet 6 inches. Protection in this instance to be really effective must cover the limits of size at which these lizards actually breed, as this would enable a larger number to attain maturity and to reproduce their young. In discriminating between the various species and fixing the limits below which they are to be protected, it would be pertinent to inquire whether the size at which they attain maturity has been correctly ascertained. Again where the habitats of the various species

overlap, as they often do, there would arise the difficulty of the villagers being able to distinguish between the different species,—not a simple matter even in museum specimens.

It is possible that the action of the Government of Bengal in placing a total ban on the killing of these lizards in the light of our present inadequate knowledge, has been to some extent premature and the suggestions put forward by the trade for the modification of Government's ruling may be provisionally adopted pending an enquiry into the facts. Such an enquiry under the guidance of a competent zoologist would be able to determine whether the various species of monitors have been appreciably reduced in numbers during recent years and whether any of the species are now threatened with extinction. A careful enquiry into the present extent of the trade and a comparison of the average numbers of skins of different species obtained from various provinces over a number of years may throw light on these points. The normal food of the various species, their breeding season and the size at which they attain maturity, are also points for investigation.

Mysore's New Game Laws

The question of protective legislation brings us to the recent amendments to the Game Laws of the Mysore State. The report of the Committee appointed to enquire into the existing conditions of game in the country reveals that there has been an appreciable depletion of game in the State in recent years, due to a natural increase in the population and to other causes more preventible. Poaching has been, as elsewhere in India, largely responsible for the decimation of game in the State forests and the decision of the Mysore Government to secure the co-operation of village shikaries in putting down poaching might, with advantage, be more generally adopted, provided the rewards are made substantial enough to induce this fraternity of professional sportsmen to give information on every occasion and, what is more important, to forego their own assumed rights as privileged offenders. Good rewards to subordinates of the Forest, Police and other departments will probably provide a check in the latter instance. Facilities for the entry of a greater number of sportsmen into the jungles of the State would be one of the most effective means of checking poaching. This, as has been pointed out to us, is proved to a remarkable degree in the shooting blocks of the Coimbatore and Kollegal forest divisions. The abolition of the system whereby blocks were taken by visitors for a whole year and the introduction of a system whereby blocks are rented for a period of one month only at a time, has resulted in the forests being much more frequently visited. At the outset the ruling met with a good deal of opposition on the grounds that the frequent entry of sportsmen would reduce the game in the reserves. The frequent visits of sportsmen to the shooting blocks and the deterrent thereby provided against would-be poachers has resulted, however, in a distinct increase in game in the forests of these divisions. Invariably more game falls to the gun and traps of the poacher than is accounted for by legitimate and regulated shooting.

Under the older regulations the poacher knew from experience that the license holder seldom revisited his block during the year after one shoot and was able to carry on his trade without hindrance. In increasing rewards for the destruction of wild dogs, the Mysore Government have set an excellent example. Government now offers a reward of Rs. 50 for a wild bitch and Rs. 30 for a dog. Substantial rewards will naturally provide a greater inducement to the villagers who, it must be understood, have reasons for regarding the wild dog more in the nature of a friend than an enemy as it provides them with meat on occasions when they are able to annex its kills.

Discrimination should be exercised however, in the payment of these rewards as frauds are continuously being perpetrated by the production of skins and skulls of defunct pie-dogs, and jackals. On several occasions we have examined skins and skulls of reputed wild dogs for which rewards had been paid and which proved to be those of domestic dogs and jackals. Deception has been carried out to the extent of dyeing the skins of village pies to give them the colouration or a nearer resemblance to their feral relatives. A chart issued by the Society and used by Forest Departments in India and Burma will be found useful in assisting officials to identify skins and skulls sent to them for comparison and in detecting attempts at fraud. The introduction of rules for preventing land owners from pursuing and killing game beyond the limits of their occupied holdings will be effective in checking unnecessary slaughter of game. The Committee have found that the privilege conferred on land owners to kill and capture game with a view to ensure protection of their crops is being abused. The same would apply to territories outside the Mysore State. The clash between human interests and the question of the protection of animal life is a problem which will increasingly arise with the continued usurpation by man of the domains of wild life. A solution of the problem can only be arrived at by the combined efforts of politicians, sportsmen and naturalists to discover a means for the protection of animals which will be acceptable to people in each country. The action of the Mysore Government in abolishing rewards for the killing of tigers might be with advantage generally adopted in India, except in districts where tigers are a distinct pest. A stricter control over poaching would not affect the issue in the case of such tigers as are confirmed cattle-lifters, but it would, by providing tigers with their natural food, probably have a beneficial effect on the protection of cattle from potential offenders.

Bird Migration, Etc.

In May we had the pleasure of receiving Rear-Admiral Lynes with his two companions, Messrs. Hugh Whistler and B. B. Osmaston, who were proceeding on an ornithological expedition to Kashmir, Baltistan and Ladak. We are glad to have been able to assist them by loaning the services of our Assistant Curator, Mr. V. S. LaPersonne, to collect birds in Gilgit, where but little work has been done since the days of Col. Biddulph, and we look forward

to valuable results. We also hope that the material collected on the trip will enable Mr. Whistler to write the detailed avifauna of Kashmir for which he has been gathering records and notes for some years past. In addition to many useful ornithological contributions to this and various other Journals from time to time, his latest work *A Popular Hand-book of Indian Birds* reviewed on page 180 of this number, is convincing proof of his competency to undertake a work of the nature he contemplates, and we feel sure the compilation will do justice to his reputation. As a popularly written illustrated guide to the commoner birds of this country the *Hand-book* fulfils its purpose admirably and we would recommend it to every bird lover.

While on the subject of popular natural history books, we must not omit to congratulate Mr. F. W. Champion on the necessity of his having to bring out a second impression of his wonderful volume *With a Camera in Tigerland* considering that it made its first appearance only as recently as eight months ago. The reception deservedly accorded to this work is an indication of how anxious the public are to welcome well-illustrated popularly written books on Indian Natural History, and we confidently hope that ere long we shall have the pleasure of announcing yet a further edition.

Admiral Lynes' party, as also Mr. F. Ludlow whose ardent roving spirit has now carried him far into the confines of Tibet, have been supplied with a series of aluminium bird-marking rings bearing the inscription 'INFORM NATURAL HISTORY SOCIETY BOMBAY, No. (. . .)', and from the keeness of these ornithologists we have every hope that they will concentrate their attention on ringing any nestling wildfowl they happen to come across.

In connection with the subject of Bird Migration, readers are referred to our remarks on page 577 of volume xxxii. By the time this number is in their hands many of our winter immigrants will already have arrived and streams of others will be pouring in apace to swell the incoming tide. Where exactly the birds come from of course we do not know, neither can we tell the routes they take, nor their precise destination, nor indeed the manner in which they travel. Do the same individuals visit some favoured locality year after year, or do they fortuitously 'drop anchor' just wherever favourable prospects of food tempt them? Do birds of a flock, after breaking up for breeding purposes on return from this country, again reunite when travelling to or sojourning in their winter quarters? A host of other interesting questions confront us and force upon us a realization of the full measure of our ignorance. Yet there is no real reason why our ignorance should be so profound; much knowledge can—and, in other countries, has been—acquired by a careful and systematic co-ordination of results obtainable by the simple and only effective method—that of 'ringing' birds. Manifestly, however, the optimum results can be attained only with the active co-operation of the countries beyond our northern frontiers to which our migrants retire for breeding purposes—i.e. their summer quarters. To ensure this co-operation the Society wrote sometime back to Prof. B. Shitkov, the Director

of the Zoological Museum, Moscow University, asking if he would co-operate in the bird marking scheme which we were contemplating by arranging to report recoveries of our ringed birds in Siberia, as he was good enough to do in the case of the ducks ringed in Dhar State. We have received an extremely gratifying communication from him; he writes to say that he has had a translation made of our letter and circulated it through the Biological Experimental Station in his charge to various ornithological and sporting magazines and organizations in European Russia and Siberia, so that the Society's ringing scheme is assured a wide publicity in that country. Prof. Shitkov informs us further that regular operations in the marking of birds are at present being carried on over a considerable portion of Asiatic Russia by the Biological Station of Young Naturalists (Moscow) whose rings bear the following inscriptions :—

БЮН

MOSKWA
No. (. .) (Series)/A

Members therefore may look forward with greater hope than drawing the winner in the Calcutta Derby Sweep to come upon birds bearing these rings during the coming shooting season, and should any have such luck, we shall be grateful if they will forward the ring to us giving the species, sex, date, locality and other particulars relating to the specimen.

For our scheme we now want a band of enthusiastic workers who will take up ringing work in earnest and help towards the elucidation of some of the knotty problems of bird migration as it affects us in this country. Residents in some of our duck-shooting provinces, such as Sind and others in the north, have unparalleled facilities at their disposal and can do a great deal. Wildfowl are netted in large numbers everywhere in India during the cold weather, and no elaborate or expensive apparatus for trapping birds is called for. The fowlers could be induced to part with their captures for a consideration which would be inconsiderable as compared with the value of the birds after being transported to the market. It is quite likely that many of the birds thus ringed would be recaptured, or if spared continue to be recaptured in the neighbourhood until the proper exodus commences in the hot weather. The fowlers could be asked to record recoveries of such birds, and we have no doubt that in many cases it would be possible to arrange with them to give marked birds their liberty again.

We shall be glad to supply any further information members may require, and to furnish full instructions as to how ringing may be done.

We extend our sincere condolences to Col. R. Meinertzhagen. The recent death of his wife under most tragic circumstances has deprived him of a devoted helpmate and companion who shared with distinction his important work in the field of Ornithology. On behalf of the Committee and members of the Society we offer him our deepest sympathy.

MISCELLANEOUS NOTES

I.—A NIGHT ON AN OBSERVATION MACHAN IN THE BILLIGIRIRANGANS

A party of us (Mrs. A. S. Vernay, my wife, Mr. H. Sanderson of New York and myself) recently spent a night on one of my two observation machans in these jungles. The machan overlooked a large water-hole. It was a wonderfully bright moon-light night. The machan was large enough for the four of us lying at full length and as we had our bedding we slept at intervals. At about 9 p.m. a solitary tusker with a single tusk came out of the jungle and spent a refreshing half hour drinking and deluging itself with muddy water. It then approached our side of the clearing in which the water-hole is situated and stood in perfect silence for some time as though suspicious of its surroundings : and then stalked majestically away. The tree on which the machan was built was well rubbed on one side by an elephant on some previous date and we thought it possible that this tusker might do the same! About an hour later a stag sambhur with a splendid head walked out of the jungle and across to the water-hole and, after having a drink, lay down and wallowed for about a quarter of an hour before getting to its feet and entering the jungle on the other side of the clearing. At about midnight a herd of about twenty-three bison, including two big bulls, came down and we spent a most enjoyable half hour or more watching them drinking and walking in the swamp. It is a curious fact that elephant, bison, and sambhur do not seem to be worried, on moon-light nights, if a spotlight is thrown on them. I shone my 'Lite-Site' on the sambhur and bison and their eyes reflected the light back but apart from their looking up at what they probably thought was an extraordinarily bright star the light did not seem to trouble them a bit. I have done the same with elephants. Before re-entering the jungle two young bulls or cows in the herd had a playful set-to which was amusing to watch. Nothing further was seen that night but what we had seen was quite sufficient reward for our walk of eight miles to the machan. I think there is nothing more delightful than sitting up on a moon-light night observing game, in a jungle thick with elephant, bison, and sambhur, coming down to water. We had the choice of two machans and would have seen about the same from each as it turned out from an examination of the water-hole at the other machans, for here also a herd of bison had been down to drink, and sambhur, and a solitary elephant, which had removed the bamboo ladder. This would have added to our excitement and interest had we been there!

HONNAMETTI ESTATE,
ATTIKAN P.O.,
Via MYSORE,
March 10, 1928.

R. C. MORRIS.

[Mr. Morris's experience indicates how much pleasure and opportunity for observation of animals in their natural state may be secured when the killing of game is not the main purpose. The

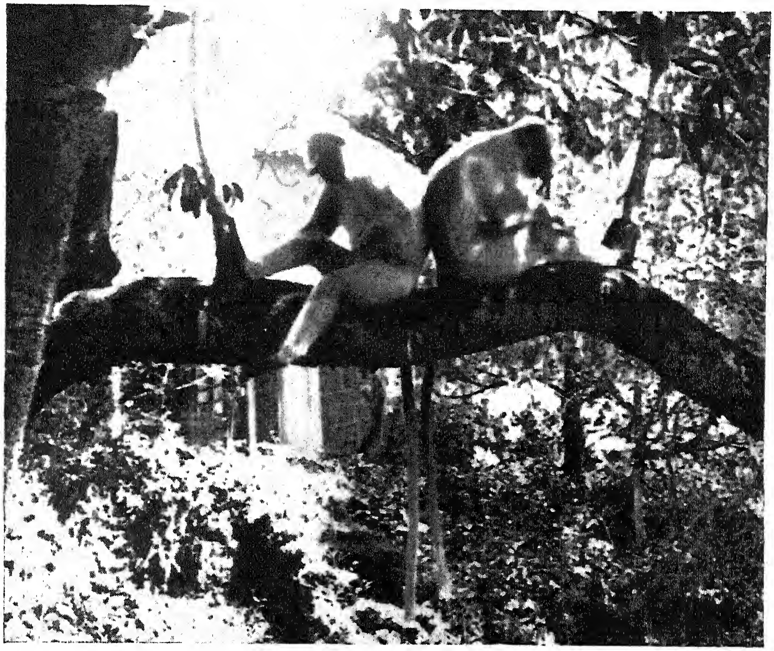
building of observation machans by those who have the opportunity and the time is a feature which we would like to see more generally adopted. EDS.]

II.—NOTES ON THE COMMON INDIAN LANGUR (*PITHECUS ENTELLUS*)

(*With a plate*)

A description of this familiar monkey is unnecessary. Mr. Pocock in a recent paper in this journal has outlined the distinguishing characters of its various races and their distribution. Looked upon as sacred by many Hindus for the part he played in the rescue of Sita from captivity at the hands of Ravana, the dread Rakshasa of Lanka, the Hanuman monkey enjoys the benefits of a rigid protection which has made him a positive nuisance in many parts of the country. After one leaves Ahmedabad by the narrow gauge line of the Rajputana Malwa Railway, these langurs are a familiar sight on the railway stations. They even make bold to enter the carriages to receive offerings of food and on one occasion I had two great fellows seated on the window sills of my compartment complacently eating the fruit I gave them. They accepted all they got as a right, but resented and were suspicious of any familiarity. A waggon-load of these monkeys was once despatched on this railway to a destination several stations beyond their home town. This was the last desperate effort of its human inhabitants to rid themselves of at least some of the members of a community who were amenable to no laws, respected no property rights, and transgressed every rule of good citizenship. Unfortunately the deportees were detrained at a station which already had a surplus and thriving monkey population. Active and hostile demonstrations against this newly arrived band of reverend signors with their dames and children was out of the question. Besides the monkeys had already scattered all over the town so the situation, intolerable as it was, had to be accepted. But it has led to bad feeling amongst the citizens of these otherwise quite friendly towns. The practice of using monkeys as a medium for paying off old scores is not unknown. A quantity of grain scattered on a neighbour's roof as a lure to the observant and willing langurs will result in the turning over and the destruction of a goodly portion of his tiles. Unfortunately there is no effective method of preventing a return match on your own roof as the langurs are willing to oblige all parties without prejudice.

A great part of the langur's dietary consists of leaves and young shoots of trees. Blanford points out that they appear to be immune against certain vegetable poisons. Doses of 5 to 10 grains of strychnine have been administered to a Common Langur without effect, while the same dose kills a *Rhesus* monkey in a very short time. In North Kanara, where the tree (*Nux vomica*) grows from which strychnine is obtained langurs eat quantities of its fruit which they seem to relish. The langur is a sociable animal and lives in larger or smaller communities, comprised of individuals of both sexes and varying ages. The adults differ considerably in size and weight and also to some extent in colouring. A male measuring 5′ 6″ in extreme length, weighed by Shortridge scaled 35 lbs.,



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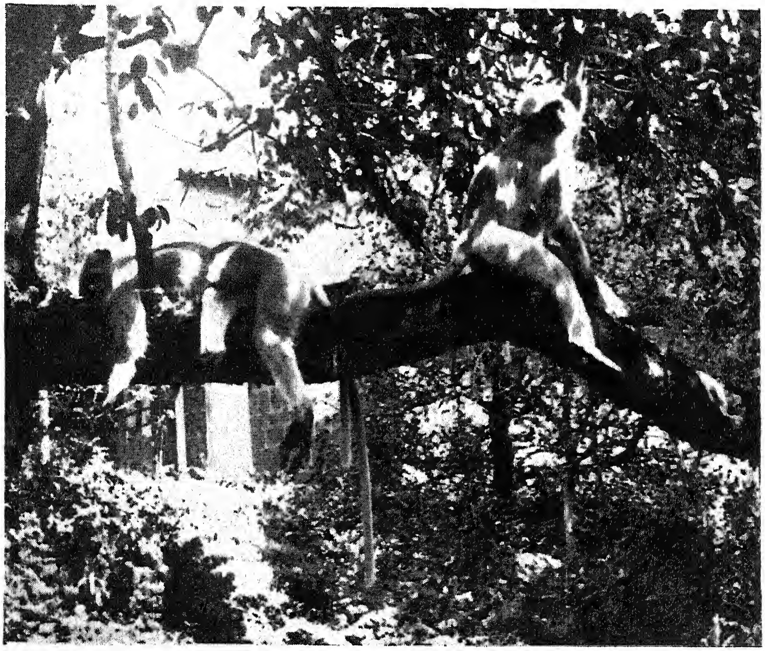


2.

LANGURS AT THEIR SIESTA.

while a full grown female was 27 lbs. The young ones cling to their mothers and are carried about by them. Mr. Crump while collecting on the Mammal Survey observed a female playing with her baby. The mother grasped her little one with both hands and tossed it into the air catching it again as it reached the ground. The extreme agility of these monkeys and their astonishing aërial gymnastics amid the tree tops have been the wonder of all who have observed them. They can reach the ground from the tops of the loftiest trees in about four leaps or more correctly drops. The drops are made in quick succession in an upright position ; not as a rule among the heavier boughs but among the foliage and lighter branches. When alarmed while running they frequently raise themselves to their full height to look around and on the tree tops will cleverly conceal themselves by grasping and drawing the branches together, becoming completely hidden. During the hotter parts of the day, the troop generally retires from the hillsides to the watercourses where they rest in the cool shade of the trees. When at rest they assume quite human attitudes. My camera has caught a pair of them sitting back to back on a branch for mutual support. The second picture shows two of them in a recumbent attitude. When disturbed by clapping they almost dropped off their perch in fright. Perhaps after all there is some foundation for the belief that a panther is able thus to capture a somnolent monkey which loses its perch when startled out of its wits by the sudden coughing roar of the feline. A friend of mine while collecting in Tennasserim fired at a flying lizard clinging on the trunk of a lofty tree; the report to his surprise brought some heavy object crashing down through the branches overhead. This he discovered was a monkey which had presumably toppled off its seat on hearing the sudden bang and which would have certainly come to earth had he not managed to get a hold on one of the branches *en passant.* In his recent interesting book *Birds and Beasts of the Roman Zoo* Knottnerus Meyer records that at a sudden clap of thunder, a macaque in his charge fell dead from its perch.

Many people will have noticed how some wild animals in India and domesticated ones for that matter, immediately distinguish between Indians and Europeans. Black buck will graze peacefully in a field where cultivators are working ; to them the turban is an emblem of mutual toleration while the hat means trouble and is a thing to be avoided. Shortridge when collecting in Kanara notes how the langurs looked on him with the deepest suspicion while they paid little regard to the Indians in his camp. As a rule Langurs which live in forest away from human folk are much shyer than those found about towns and villages. In many parts of India they are hunted and eaten by forest tribes. The Kathkaris of the Konkan are exceedingly fond of langur meat and will lose no opportunity of securing such a meal of which no part ever goes to waste. In South India the Nilgiri langur is also eaten and different parts of his anatomy are looked upon as a curative for different diseases. The Kathkari's method of hunting the langur is to isolate a party, the men then surround the tree and set up a tremendous din shouting 'Ho-oooo, Ho-oooo.' The wretched monkeys bewildered and terrified by the noise crouch motionless among the branches and

are then picked out and shot down with arrows. The Kathkari has a neat and effective way of carrying his victim after shooting it. A slit is made in the tail of the langur and the end of the tail is slipped through it to form a noose, the head and limbs are passed through the noose which is then pulled tight. He thus has a trim and compact parcel which he carries like a portmanteau! At the end of the day the hunters gather round for the division of the spoils. A fire is kindled and the monkeys are placed over it. The hair is soon singed off and the animals partially roasted. This done, the meat is apportioned off, arrow heads or knives being used for cutting it up. The entrails are also taken washed and divided. After this, dinner commences immediately or each mán takes his portion home and cooks and eats it.

I once asked one of these simple people whether they ever ate the macacque. His reply was not very complimentary: 'Never,' said he, 'the red-faced monkey is a European'.

BOMBAY NATURAL HISTORY SOCIETY,
June 15, 1928.

C. McCANN.

III.—A CARELESS TIGER

To-day about 3.30 on my return from the forest I got 'khubbur' of a tiger kill. I sent off my men to build a machan and at about 4.30 took my seat in a bush about 4 feet off the ground. The kill was lying in some dense cover near a river. I sent my men away talking and they had not gone fifty yards when the tiger appeared. Just when excitement was at its height I heard somebody approaching and one of my chaprasis appeared who wanted to know if I needed an extra five rounds of ammunition. Some of your readers may guess my answer! However he went off coughing and spitting, I presume to get the nasty taste out of his mouth. The tiger all this time had taken cover behind a bush and was watching through the branches I remember it struck me at the time how amazingly inconspicuous he was. My chaprasi was not out of sight when he came straight up to the kill. I was using a ·375 Mannlicher Schönauer and my fist shot was a misfire. The noise of the bolt sounded like a thunder-clap and the beast looked straight into the machan. I reloaded quickly and shot him stone dead with a shot between the eyes.

What struck me as extraordinary was the complete lack of caution in approaching the kill, even then the noise of the bolt did not scare the beast away. I was the more astounded when I found that the animal had been very severely wounded some time before by a gunshot apparently a handful of small round bullets. One eye had been completely destroyed and I found no less than 7 bullets in the skin and muscles surrounding the jaws; one upper canine was broken and the nasal septum for about an inch and a half was severed. At the time of his death this young male (9 feet between pegs) was in fine condition and with all wounds completely healed.

He cannot have been in great hunger as he had eaten half the bullock during the previous night.

One would have thought that 'once bitten twice shy' combined with the native caution of the tiger would have made this beast somewhat chary of approaching his kill without a proper examination of the ground.

Another point to note is the great recuperative power animals in the wild state possess. This animal was little the worse, bar the sight of an eye, for what must have been a ghastly wound.

I am informed that three years ago a Nepali when out poaching in Reserved Forest met a tiger face to face. He chanced his aim and took a shot which apparently laid the tiger out. On going up to the fallen beast it sprang up, attacked and killed him and then bolted. The incident happened about three miles from where I shot my tiger.

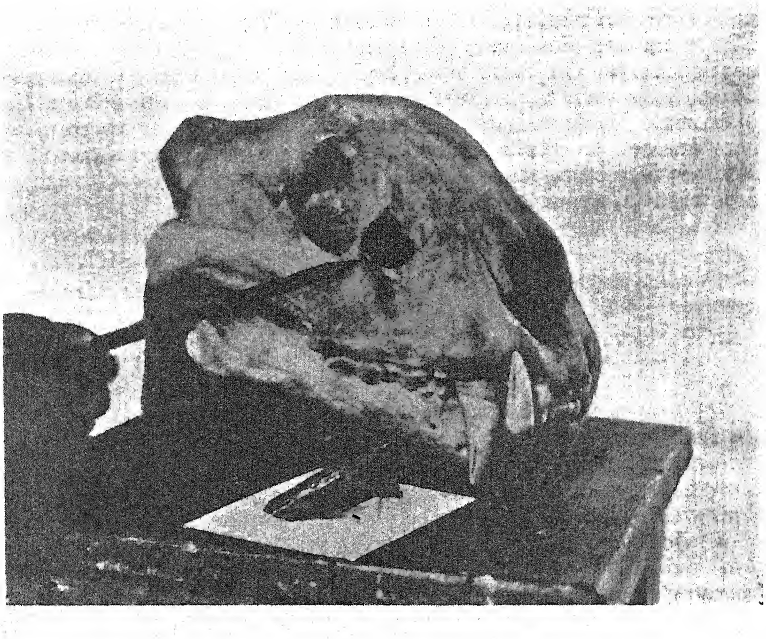
These are very good grounds for believing that the same tiger is the hero of both stories and in view of the above I much regret having slain a beast which was such an efficient game keeper.

So perish all poachers !

KOCHUGAON P.O.,
GOALPARA DIST.,
ASSAM,
June 8, 1928. N. L. BOR.

IV.—AN UNUSUAL FIND IN A TIGER'S SKULL

We enclose photograph of a tiger skull and in the fore-ground (on the sheet of paper) a piece of sambur horn 2¾″ in length which



was found embedded in the skull just below the eye. This may be of interest and worth recording.

The tiger was shot by Captain D. B. Mackenzie, 5/13 F. F. Rifles 60 Cantonments, Belgaum, who writes us :—

'The sambur tine when the tigress was shot was under the, skin and not visible. There was a small hole in the skin which I took to be the exit hole of the second bullet. It was in skinning the head (which I did myself) that I came on the tine.'

VAN INGEN & VAN INGEN.

MYSORE, S. I.,
April 19, 1928.

V.—TIGERS CLIMBING TREES

(*With a plate*)

Believing that it might interest you, I am sending you a photo of a tigress perching high up in a tree in the Mysore Zoo. She is a full grown young animal, captured about eight months ago. Two weeks after capture, when she was let out for the first time, she took a jump up the tree about 20 feet in height and stretched herself on a branch for three complete days and nights till starvation compelled her to return to her cage. Thereafter she would repeat this performance every time she was let out into the open enclosure. A platform has now been built on the tree where she climbs up and lies every time she is let out, for over 24 hours continuously. On Saturdays, she is given a goat to eat and very often she is seen taking the kill up the tree and eating it on the platform. We have got another platform about 6 feet high made near another tree with a view to teach the other tigers to follow suit, the idea being to raise this platform gradually till it reaches the height of about 20 feet or so.

SADEG Z. SHAH,
A.D.C. to His Highness the Maharaja.

THE PALACE, MYSORE,
April 12, 1928.

[Those who have had the opportunity of seeing that marvellous picturization of wild life in the jungles of Siam in the now famous film 'Chang', will recall the incident in which a close-up view of a tiger was obtained as it climbed 11 feet up the trunk of the tree upon which the cameraman was placed. From an account of the film published in the *Scientific American* it appears that the operator's platform was 13 feet from the ground and that the last exposure recording the climb was made when the tiger was 2 feet

AN ARBOREAL TIGRESS, MYSORE ZOO.

from the lens. Comment on the extraordinary coolness and intrepidity of the operator is unnecessary!

Several records of tigers climbing trees have appeared in the Society's Journal which would tend to show that a 20 ft. margin between a machan and the ground is within the compass of an agile tiger's reach. Mr. G. Monteath writing in the Journal, vol. xxvi, p. 837, records an incident in which a wounded tiger took a boy out of a tree 20 feet from the ground. The lowest claw mark on the tree was 3 feet from the ground and the highest 21 feet, which indicates that the tiger not only leaped but also climbed, though the climbing in this instance was only a couple of jerks—a few feet at the most. Brig.-General R. G. Burton has provided the Journal with several incidents relating to tigers in trees (vol. xvii, p. 385). A record from the *Bengal Sporting Magazine* 1834 tells of a tiger which had been wounded the previous day, being found dead on the branch of a Peepal tree 15 feet from the ground. Claw marks on the trunk of the tree indicated that the tiger had scrambled up cat fashion. Other instances include a record from the *Sporting Review* (1856) of a tiger, treed by a party of villagers, climbing up to a sturdy branch 25 ft. from the ground, and a second instance of a similar nature in which the tiger ascended to a height estimated at 9 ft. The most remarkable incident of all, however, was taken from the *South of India Observer*. A tigress in the course of a hunt was finally observed lying on a branch 30 ft. from the ground. On being knocked off her perch apparently lifeless—she recovered sufficient energy to scramble up the same tree and regained her lofty perch, 'shinning up the trunk exactly as an ordinary house cat would'. The tree in this instance was perpendicular, a foot in diameter and with no branches for 25 ft. Champion in his *With a Camera in Tigerland* speaks of a wounded tiger ascending a tree to get at a party in a machan 16 ft. from the ground. It is interesting to add that the tiger in the Mysore Zoo has a countryman in the New York Zoo who on receiving his daily rations invariably leaps with it on to a platform some 10 ft. above the floor of his cage. EDS.]

VI.—TIGER 'POOKING'

While sitting up over a tiger's kill near my estate recently I heard the tiger coming down the hillside nearby roaring at intervals. On nearing the kill its suspicions were apparently aroused and the tiger *pooked* with a suddenness that made me jump. The sound resembled a sambhur's bell in a remarkable degree but in a key similar to the very distant bell of a sambhur. In this case there was no question of distance as the tiger was close to my machan and there were no sambhur in the vicinity. The tiger 'pooked' only once and went off without another sound.

Two years ago my wife was sitting up over a tiger's kill with Major Brooke Purdon, R.A.M.C. The machan was badly built and on an ill chosen tree. The tiger came at nightfall, scented danger, and instead of approaching the kill roamed the vicinity 'pooking',

the sound being exactly as I have described above. It may be better described as being similar to the querulous bell of a young sambhur a long distance off. Here again there were no sambhur about.

HONNAMETTI ESTATE,
ATTIKAN P.O.,
Via MYSORE,
March 9, 1928.

R. C. MORRIS.

[Many notes have from time to time appeared in the Journal regarding the extraordinary sound produced by tiger, resembling a sambhar's bell and variously known as 'pooking', 'titting' (in Burma) and such other names. Whereas the original suggestion was that this call is a means by which the tiger locates the presence and position of a sambhar by inducing him to bell in response, we think sufficient evidence has now been adduced to justify the conclusion that it is nothing more than a note of suspicion having also at times some sexual significance by helping to keep a pair in communication with each other.

It seems hardly likely that a sound which, with but casual experience, a sportsman can almost invariably distinguish from the bell of a sambhar, would delude so wily a creature as that deer into the belief that it was a challenge from one of its own species, and the decoy theory, however ingenious and plausible it may at first sound, may in our opinion, now be safely set at rest. EDS.]

VII.—SAMBHAR AND WILD DOG

While out after elephant I heard the screams of a sambhar and knew at once that a sambhur or two were being attacked by wild dogs. I had to go through long grass to reach the spot where the screams came from and was seen by the dogs who scattered and I missed with two snapshots.

From some distance I saw the sambhur hind pluckily trying to defend her fawn from the attacks of seven or eight dogs. Every time a dog approached her fawn she would rush forward striking at the dog with her fore-feet; the dog retreated, and this only gave the dogs behind a chance to attack the hind in the rear and the fawn from the other side. On coming up to the sambhur I found that both were in a terrible condition, the fawn's anus having been torn out and its buttocks also bitten away. The hind was very severely bitten in its hind quarters and udder, and as I considered that neither of them would last for more than a few hours and would anyhow be at the mercy of the dogs when they returned, I shot them both and reported the matter to the District Forest Officer.

HONNAMETTI ESTATE,
ATTIKAN P.O.,
Via MYSORE.

R. C. MORRIS.

VIII.—WILD DOGS ATTACKING CATTLE

After reading Mr. Randolph Morris' remarks on Wild Dogs attacking cattle in the Journal of August 1, 1927, I wrote to Captain Peter Gilpin, the manager of one of the biggest ranches in Southern Rhodesia, and received the following letter from him, which may be of interest to some members of the Society.

'For your information I enclose figures of cattle killed by various wild animals. These figures only cover the last few months. We keep very strict records of all deaths, and I can guarantee the enclosed list to be correct. In my opinion wild dogs are far worse than lions and far harder to kill. I have known them pull down a full grown bull, kill it and eat it in a very short time. Any hunter will tell you they kill sable, koodoo, etc. I have not heard of them killing buffalo, but I expect they could if they wanted them. I have known packs go up to a hundred strong; a pack of this size will kill anything that they meet.

The following list represents number of cattle killed by the different wild animals from January 1 to October 31, 1927.

Wild Dogs	...	504
Lions	...	537
Leopards	...	177
Crocodiles	...	179
Hyenas	...	52 (Hyenas only kill calves).

In the last 12 months we killed

Lions	...	56
Leopards	...	72
Wild dogs	...	72
Cheetas	...	16

and a large number of crocodiles, hyenas, etc.'

GOVERNMENT HOUSE,
SALISBURY,
SOUTHERN RHODESIA.
November 20, 1927.

H. G. GREGORY SMITH,
Captain.

[The wild dog referred to in the note is obviously the animal commonly known as the Cape Hunting Dog (*Lycaon pictus*), a creature of about the same size as our own Red Dog or 'Dhole'. These creatures also work fearful havoc with game in Africa often completely clearing out whole districts. Like their Indian prototype, they have a wonderfully developed power of scent combined with remarkable endurance, pertinacity and speed, and two or three dogs working in unison are sufficient to run down and kill such large and powerful animals as the Koodoo and Sable Antelope. At times they apparently hunt in much larger packs than is the case with our Indian *Cuon.* EDS.]

IX.—A NOTE ON THE MALAYAN WILD DOG (*CUON RUTILANS*)

(*With a plate*)

That little hunter, *Cuon rutilans*, has been the subject recently of more than one article in the Society's magazine. I enclose a photograph of him taken near a bull terrier of average size.

On December 8, I saw this specimen, a solitary male, run a young sambhar stag into a pool in the Wesalun stream. Favoured by good cover I approached within 10 yards and obtained a good view of *Cuon* at work. The sambhar, very exhausted, struggled in water upto his withers with the dog fastened to his head. During the short time prior to my interference the sambhar had been twice pulled off his feet and submerged. Later examination of the body revealed a number of wounds about the head and neck and a few on the flanks. No single wound was really serious and I have little doubt that death in this instance would have resulted from drowning. There were no signs to show if attempts had been made to emasculate the sambhar.

I shot the dog. The sambhar's face and particularly the eyes had been badly torn. This fact with his evident extreme exhaustion led me, too hastily I am afraid, to shoot him also.

The sambhar bleated piteously during the struggle with the dog. The sound resembled the usual 'Tit' note prolonged into a bleat.

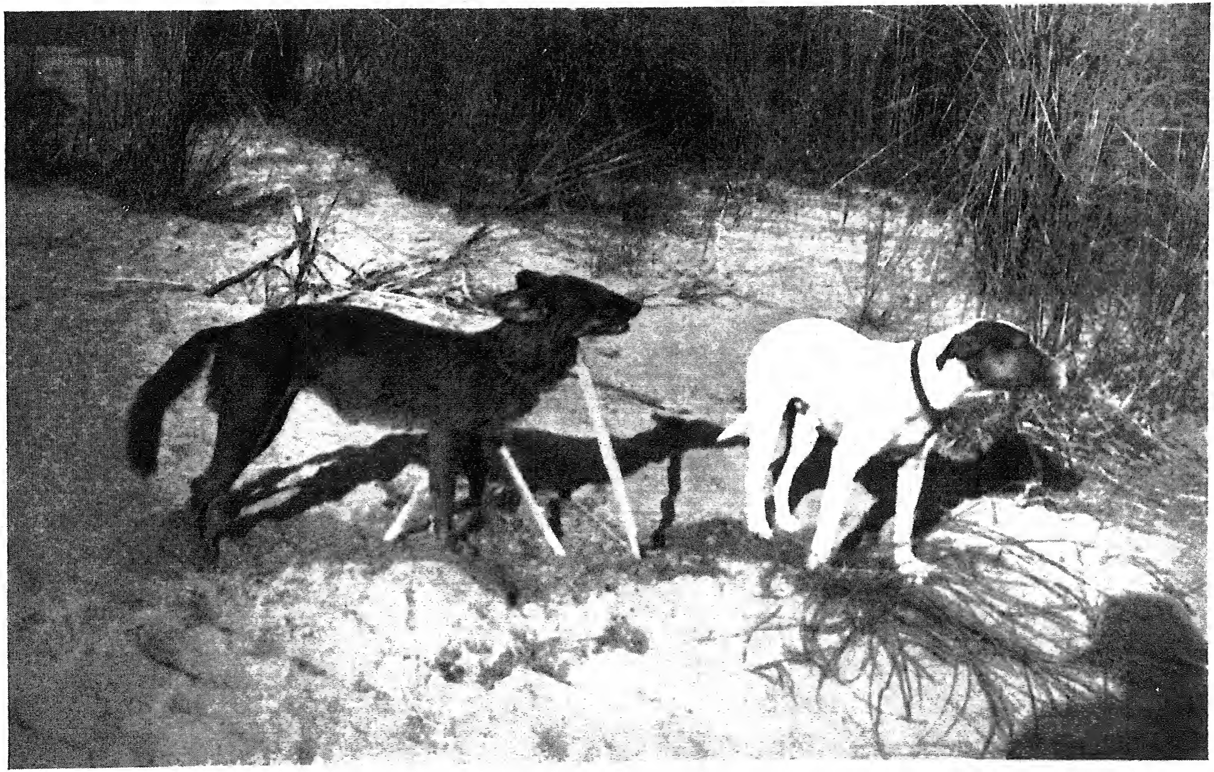
This is the third instance I have known of solitary wild dogs running deer in the Upper Chindwin District. The two previous occasions concerned barking deer, the remains of which I found with unmistakable signs that they had been killed by solitary dogs and not by packs.

I have often speculated on the reasons why wild dog 'kills' should invariably be found in the beds of streams. The sambhar in the instance described appeared so helpless in comparatively deep water, that I am inclined to credit *Cuon* with a deliberate intention to shepherd deer to water, or perhaps more truly with allowing deer to take to water before closing with them. I remember two instances of deer being pulled down by pariah dogs, and in neither case was the kill made near water although streams were handy. A few weeks ago I followed a slightly wounded barking deer stag with the bull terrier in the photograph. The deer did not attempt to make for water and was run into and held some distance from the nearest stream. Of some dozens of wild dog kills I have seen in Burma I do not remember to have seen one that had not been made in the bed of a stream.

One frequently speculates on the probable results of a fight between a wild dog and a domesticated one. I may remark that *Cuon* in this case showed no greater tenacity or strength of jaw than a bull terrier, and I think if this one had clashed teeth with the dog in the photograph he would have had a very thin time. But perhaps some reader could adduce evidence to the contrary.

MAWLAIK,
UPPER CHINDWIN
DISTRICT,
March 31, 1928.

E. H. PEACOCK.



A STUDY IN RELATIONSHIP.

A Malayan Wild Dog (*Cuon rutilans*) and Terrier.

X.—COMMENTS ON THE AARDWOLF (*PROTELES CRISTATUS*, SPARRM. MENTIONED IN 'A SPORTING TRIP TO SOMALILAND', IN THIS JOURNAL

I notice in vol. xxxii, No. 2, p. 303, the following 'our only experience of Aardwolf (*Proteles cristatus*, Sparrm). The name "Earth wolf" is deceptive as this animal is no wolf at all. He lives underground, is of a reddish-brown colour and stands about 18″ from the ground.'

From the above it is difficult to believe that the animal encountered was an Aardwolf, a creature which can be compared to a small and rather thin striped hyena, with proportionately long ears, a more pointed muzzle and remarkably weak teeth. Possibly it should be regarded as an abnormal member of the civet family (*Viverridæ*), which, perhaps for the purpose of escaping attack, has 'mimicked' the striped hyena.

Standing from 18″ to 20″ at the shoulder, the Aardwolf (or burrowing wolf) has a long handsomely coloured coat, striped with dark transverse bands on a light ground and an upright mane: the legs being similarly but more scantily barred, and the tail thick and bushy. It feeds to a great extent on white ants (termites).

In the Somali race the ground-colour of the coat is creamy white, with a slight wash of buff on the neck and sides of the rump, but with no trace of grey; while the stripes are less defined and on the neck broken up into spots, and the mane is black, somewhat variegated with creamy white.

From this description of Lydekker's and from specimens I have handled it is hard to believe that the animal seen was an Aardwolf.

If an ant-bear (or aard-vark) had been encountered there could have been no mistake in identity. Perhaps the sportsman who made the trip to Somaliland can throw further light on the matter.

C. R. S. PITMAN,
Game Warden, Uganda Protectorate.

ENTEBBE, UGANDA,
January 12, 1928.

XI.—AN UNUSUAL ALTITUDE RECORD FOR THE BARKING DEER (*MUNTIACUS VAGINALIS.*)

I send herewith the particulars of a barking deer shot at Yatung, in the Chumbi Valley of Tibet.

Length 5¼ inches.
Tip to tip 5¾ inches.

I have not heard of barking deer being shot at this height (10,000 ft.) before, and thought that it might be of interest to the Society.

C/o THE RESIDENCY,
GANGTOK, SIKKIM.
April 14, 1928. A. A. K. SANGSTER.

[The Barking Deer or Muntjac is not usually found above altitudes of five or six thousand feet. In the Himalayan jungles and hill

forests of Kashmir however it ranges up to about 7,000 feet while in Nepal it has been known to ascend to 8,000 feet or even higher, but has apparently never been obtained as high as 10,000 feet and Mr. Sangster's note forms an interesting addition to our knowledge of the altitude to which this little deer ascends. EDS.]

XII.--ABORTED TUSKS IN ELEPHANTS

I was recently out after a proscribed rogue elephant and, having had him marked down one morning, I came up to him after a fair tramp and found him browsing on a steep hillside on the edge of a shola, and as I worked round for a good position he entered the shola. The sun was well up and I feared that I would not see him out again till late in the afternoon and decided to take the best shot I could from the edge of the shola. I took the ear shot but unfortunately must have just missed the brain as, though the shot brought him down (I was using a ·450 H.V.), he recovered before I could get in my second barrel and went off with a shrill trumpet. I realized that it was possible that he would take a short cut across a steep open hillside in order to reach a large patch of evergreen jungle down below, and this proved correct. As he came out into the open below me I fired again but the elephant travelling at a good pace the bullet again missed the brain but knocked him clean off his feet and he then did the most amazing roll that could be imagined. He rolled over and over for about 50 yards down the hillside, crashing into the shola down below and would have rolled still further had he not been stopped by a big tree which was nearly uprooted. From the hillside, above I could not see whether the elephant was dead or alive. I had to scramble down to the edge of the shola and found the elephant had regained its feet and was slowly breathing heavily, walking along an elephant path. For a moment I was absolutely astounded as I imagined that the fall would have at least disabled the brute even if my bullet had not done its work. I did not lose much time, after my momentary pause from sheer astonishment in following up the animal, and after some trouble in carefully tracking him through high grass came up to him again, seemingly none the worse for his roll, and finished him off with a shot behind the ear.

This elephant was a single tusker, that is to say it had only one tusk showing. It was an enormous brute measuring 10 ft. at the shoulder, and had been severely bruised and cut by his roll, his knees and the top of his head suffering the most. This is the second elephant I know of measuring 10 ft. or more, another single tusker shot by Major Brook Purdon three years ago measured just over 10 ft. This is interesting in view of Sanderson's dictum that a 10 ft. elephant did not exist. On cutting out the tusk of Major Brook Purdon's elephant we decided to see whether there was any growth of ivory on the other side where a tusk should have been. The head was therefore cut in half and we discovered, completely encased in a thin layer of bone, a solid conical block of ivory about 9 inches long with a girth of about 11 inches at its base, the base

being rounded. There was no sign of any disease having set in or any damage having occupied. This encased block of ivory was not pointing in the right directing but considerably inwards. I decided therefore to find out whether my rogue held any ivory in its head on its tuskless side. Sure enough by cutting his head open I found a similar block of ivory measuring 9 inches in length with a girth of nearly 14 inches round the centre of it. The base is also rounded, but with an extraordinary lump of ivory growing out of it. It is most curious, being irregular in shape with a thin ragged wall of ivory sticking out. The block of ivory was encased in this instance also in a thin covering of bone up to where the curious wall of ivory jutted out, and this was embedded in gristle which contained 6 little balls of ivory, two about the size of marbles, two a little smaller, and two about the size of peas. It seems possible therefore that single tuskers, except those that have had the tusk broken off at or just inside the jaw in a fight or by accident, possesses this curious block of ivory on their tuskless side, and I should be very interested to hear an explanation of this.

The question arises, do mucknas (i.e. tuskless males) have similar growths of ivory ?

HONNAMETTI ESTATE,
ATTIKAN P.O. R. C. MORRIS.
SOUTH INDIA.
April 5, 1928.

[Elephant tusks are the upper incisor teeth of these animals. Each tusk, for a goodly length at its base is embedded in a bony socket. The tusk is hollow for some distance from its base upwards. In young animals this conical cavity extends into the tusk for a considerable distance but in aged animals the cavity is diminished in size. The cavity contains the tooth pulp from which the tusk is originally developed. On removing the tusk the pulp, which resembles a large conical shaped sausage, may be taken from the cavity without trouble. This pulp is a highly vascular and nervous mass of branched tissues with an outer surface or layer of cells ' the odontoblasts ' from which, the dentine or ivory of which the tusk is composed is developed. The tusk is built up in layers around the pulp, the inside layers being the last produced. The pulp may however undergo a change in the manner of its calcification ; that is to say after having gone on with surface calcification for a certain length of time, this may give place to a more irregular internal calcification tending to the formation of solid masses of osteo-dentine, an imperfect bone-like ivory, which may project inwards into the pulp cavity. This is especially prone to happen after injury and as is often exemplified upon a large scale in elephant tusks ; the pulp normally engaged in calcifying odontoblast layers into ivory may, after injury calcify irregularly and solidify into coarse osteo-dentine. The pulp of a Sperm Whale's tooth becomes obliterated by a development of coarse dentine which occasionally forms irregular masses in the pulp chamber and a similar explanation would account

for the masses of ivory discovered in the tooth socket of the elephants.

A few male Indian elephants have a single tusk only. This may be the result of injury received after the development of the tusk or may be a character developed from birth. Selous remarks that single-tusked females are not uncommon in Africa but males in this condition are rare. Again the growth of both tusks may be arrested completely in the male of the Indian elephant or they may be poorly developed differing slightly in size from the female. Mr. Morris's discovery appears to indicate that the suppression of one of the tusks in single-tusked elephants may be due to irregularities in the development of the tooth pulp from injury or other causes. Investigation would prove whether the same characters are to be found in tuskless male elephants. EDS.]

XIII.—BIRDS EATING BUTTERFLIES.

I note in vol. xxxii, No. 2, Miscellaneous Note XIV, some correspondence in regard to 'Birds eating Butterflies'.

This is a most interesting subject and unfortunately I was not collecting data at the time when daily I watched a pair of *Motacilla aguimp* (replaces *M. vidua*)—the African Pied Wagtail—consuming dozens of butterflies. What I do remember is the fact that members of the *Pierines* were unmolested. I also noted a pair of *Motacilla cinerea* catching and eating butterflies in the same locality, in a damp place near a small stream, where the insects came to obtain moisture.

I have also seen certain flycatchers and other species chasing butterflies occasionally but have no detailed records.

These observations were made in the Trans-Nzoia district of Kenya Colony, about 40 miles east of Mt. Elgon, and altitude 6,300′.

C. R. S. PITMAN,
Game Warden,
Uganda Protectorate.

ENTEBBE, UGANDA,
January 12, 1928.

XIV.—THE SPEED OF THE INDIAN PIED KINGFISHER. (*CERYLE RUDIS LEUCOMELANURA*)

While motoring down the Sirhind Canal yesterday I had a very good opportunity of testing the speed of an Indian Pied Kingfisher.

One frequently comes across these birds flying down or up a canal, but the distance of their flight is usually short and seldom exceeds half a mile or so, but on this occasion I was able to time one for just over 3 miles. The bird passed us while we were doing about 25 miles per hour and I accelerated and caught it up. I found that with my speedometer at 30 m.p.h. it gained on me, whereas I began to gain on it at 32. We crossed two bridges on the way, the bird going under them and I having to slow up on account of people and animals coming across, and here the bird got a considerable start but I soon caught it up and kept it on my

left front, so that I could gauge exactly when I gained or lost. It kept a steady course right over the centre of the canal and never changed to right or left, until it suddenly swerved, just after we had completed three miles and sat down on the far bank, near some holes in one of which it probably intends to build when the time comes. It appeard to be moving at just about its normal speed, and if this is so, the normal speed of the species is 31 miles per hour.

DHARMSALA CANTT, C. H. DONALD.
March 4, 1928.

[Modern devices such as the motor car and the aeroplane are helping us increasingly to dispel the very hazy and fallacious notions that have long been entertained in regard to the velocity at which birds and ground animals travel, and much interesting information has already accumulated through their agency.

During the war, pilots of the Royal Air Force were enabled to make a great many observations by means of the speed indicators of their machines while keeping level with flying birds. Among a host of interesting facts collected are two in relation to White Storks (*Ciconia alba*) and Mallard (*Anas platyrhyncha*) encountered migrating, the former flying at 48 m.p.h. and the latter at 50.

A comparison of the actual figures in these and other cases readily shows how erroneous were our former notions (chiefly based on extremely insecure premises) as regards the velocity attained by flying birds, especially when migrating. For example, the tiny Bluethroat (*Luscinia suecica*) was credited with a sustained speed of over 200 m. p. h. and the American Golden Plover (*Charadrius dominicus*) with nearly 250 !

Apart from the actual speed recorded for the kingfisher by Mr. Donald, his note is extremely interesting in the fact that the velocity of a flying bird in this case was ascertained by means of a car. The circumstances which enabled this were certainly exceptional and not such as are likely to be often repeated.

For ground animals, however, in suitable country the car and its speedometer have supplied valuable information and among other recent interesting records obtained in this way, is that of the Giraffe which, according to Marius Maxwell (*Stalking Big Game with a Camera in Equatorial Africa*) when hard pressed will keep up a speed of 28–30 m. p. h. for a considerable time.

Major F. H. Mosse (*J.B.N.H.S.*, xxix, p. 274) found that for a short time at any rate a Black-buck could without difficulty maintain a speed equal to the best his Ford Car could achieve, i.e., 35 to 36 m. p. h. In one case a young buck fairly ran away from his car travelling at this pace, and he estimates that even at the end of a hot chase lasting 8 minutes, the animal must have been doing not less than 38 m. p. h. He mentions an instance of a buck being shot running broadside on and as fast as a car with the speedometer showing 42 m. p. h. Major Mosse was further able to ascertain by the same means that the Wild Ass (*Equus hemionus*) of Cutch could attain and keep up without difficulty a speed of 26 m. p. h. EDS.]

XV.—THE FOOD OF HORNBILLS

A most interesting question is raised in vol. xxxii, No. 2, Miscellaneous Note No. VIII 'Is the Large Hornbill (*Dichoceros bicornis*) Carnivorous?'

The reply I should imagine is most decidedly and emphatically in the affirmative and I would point out that one genus of the family Bucerotidæ in Africa, i.e., *Bucorvus*, is entirely carnivorous.

The representatives of the genus *Bucorvus* (or Ground Hornbills) live on rats, snakes, lizards and other small animals. If caught young they make delightful and useful pets as they keep one's stores, out-houses and grain-cribs free of rats, mice and snakes. Owing to their habits and appearance they are usually known as 'turkey-buzzards' amongst the settlers.

It is a beneficial species and is protected in Kenya and Uganda.

Further, during a residence of nearly three years in Entebbe I have been at a loss to account for a steady diminution in the smaller bird life in the station. Entebbe is peculiarly situated in that it is on the site of what was once primeval forest, and as the forest disappeared its rare, skulking, feathered inhabitants remained behind and became impudently fearless and a joy to all.

To account for the decrease I have severally blamed (*a*) a pair of Eagle Owls (*Bubo lacteus*), (*b*) a small troop of Syke's Monkeys (*Cercopithecus pygerythrus*) and (*c*) native nest-robbers; but it is only lately I have discovered the real culprits—our noisy, Black and White Casqued Hornbills (*Bycanistes subcylindricus*). These marauders, though apparently subsisting principally on fruits and berries, from time to time make organized forays through the gardens and compounds, ruthlessly despoiling all birds' nests they find containing youngsters, and eating their victims.

Species that have been seen to suffer from their depredations are the bulbul (*Pycnonotus tricolor minor*), the Coly or Mouse-bird (*Coluis striatus ugandensis*) and the thrush (*Turdus lugubris centralis*). These unpleasant habits have resulted in a demand for the extermination of these Hornbills within station limits, action with which I am in agreement. The forests in the neighbourhood are well-stocked with this species, and the few which are devastating the small and interesting bird life of the station can well be spared.

The other, smaller Hornbill of the station—the Central African Crowned Hornbill (*Lophoceros melanoleucos geloensis*) is not exactly blameless as I saw one of them swoop on to a nest of the Wedge-tailed Sunbird (*Nectarinia erythrocerca*) rip it up and extract a young bird nearly a week old.

C. R. S. PITMAN,
Game Warden,
Uganda Protectorate.

ENTEBBE, UGANDA,
January 12, 1928.

XVI.—PALLAS' FISHING EAGLE (*HALIAËTUS LEUCORYPHUS*) KILLING CRANE

I was very pleased to see your picture of this vol. (xxxii, No. 3) showing such an excellent likeness of the two Cranes as we have had quite a lot of argument up here about them—as to which is called the 'Kulang'.

We get millions of the Demoiselle Crane (*Karako* or *Ghato*) but very few of the 'Kulang'—Common Crane.

It may interest some of your readers to hear the following story: While I was picnicking on the Gundull River near Husainee where hundreds of thousands of Demoiselle Cranes rest during the heat of the day on the sand islands in the middle of the river, I saw a Ring-tailed Fish Eagle (now known as Pallas' Fishing Eagle, *Eds.*) swoop down on a flock of cranes single one out, chase it, knock it down on to the ground, kill and start to eat it. I sent my shikari for it and he brought it back half eaten. Rather a large bird to tackle! Wasn't it? But what amazed me was that none of the remaining hundreds of thousands even attempted to help or rescue it although when shot and wounded they will go for one like a fencer using their beaks as a sword as I have often experienced.

F. A. C. MUNNS.

TURKAULIA P.O.,
CHAMPARAN,
March, 7, *1928*.

XVII.—WOODCOCK IN BURMA

I send you the following account of the killing of a Woodcock inside the walls of Fort Dufferin, Mandalay, as I think it may be of interest. I note that Mr. Stuart Baker in the *Game Birds* records a Woodcock being shot there in 1911.

I arrived in Mandalay from Maymyo on December 26, 1927 and put up in Lieut. A. Smith's bungalow inside the Fort walls. During tea my Chin servant reported to me that he had just seen a woodcock moving along in very low grass about twenty yards from the servants' quarters. I went out in company with Lieut. Smith (20th Burma Rifles) and flushed and shot the bird from under a small bush with a small pool of water near it. It was a well grown cock of the small dark variety and flew strongly. An examination of the ground around the pool showed that the bird must have been feeding there for some days as the ground was littered in 'borings'. The altitude of Mandalay is 200 feet above sea and the latter 10 days of December were extremely cold and foggy. Capt. Blaber (20th Burma Rifles) killed a woodcock whilst out snipe shooting at Mandalay during January. In the Maymyo District (alt. 3,4001′). I killed 43 Woodcock during November, December and January, this season being exceptionally good for them. The previous season (1926-27) I only killed ten and I shot on approximately an equal number of days. It is however unlikely that a hard working gun in the Maymyo District of Upper Burma could kill more than 50 birds in a season. The record in this District, I think belongs to Major S. Perry, R.A., who killed over 50 in 1924.

The best district in Upper Burma for Woodcock, which I know of is Haka, in the Chin Hills. In February 1927, in company with Capt. R. Cook (B.M.P.) we killed eleven birds shooting during three days, and Major Kenny of the Burma Commission killed nineteen cock around Haka in a few days during the same month.

E. H. COOKE,
Lieutenant.
20th Burma Rifles.

C/O MESSRS. GRINDLAY & CO., LTD.,
LONDON.
March, 20, 1928.

XVIII.—NOTES ON THE INDIAN PYTHON *(PYTHON MOLURUS)* IN CAPTIVITY.

On the 22nd November 1926 a specimen was received, about 8ft. long, emaciated and hardly more than skin and bone. It was put in an ordinary dealwood case. This case—my serpentarium—is 37 in. long, 20 in. wide, 18 in. deep. Half of the lid lengthwise is a plank, and half is wire netting of ½ in. mesh. The bottom of the box is covered with a layer of clean sand, which is changed from time to time, and there is a vessel of drinking water in a corner of the box.

The following observations have been made :—

A. Frequency of Sloughing.

The Python sloughed on : the December 7, 1926.
March 2, 1927.
April 16, 1927.
May 24, 1927.
August 10, 1927.
September 22, 1927.
November 19, 1927.
January 25, 1928.
March 26, 1928.

B. Diet

1926

November...	Six white rats. One palm rat. One guinea pig.	December ...	Ten white rats.

1927

January ...	Three white rats. One guinea pig.	September...	Onedead sparrow-hawk. Two crows. One guinea pig.
February ...	One guinea pig. One sparrow.		
March ...	One guinea pig. Three screech owls almost fully fledged. (*Strix flammea*). Two crows. One sparrow.	October ...	Three crows. One dead crow. Four dead rats. Four dead palm rats. Two palm rats. One guinea pig. One dead sparrow
April ...	Two guinea pigs.		

May ...	Two guinea pigs.	November ...	One koel. Five dead rats in one meal. One rat. Three guinea pigs
June ...	Three guinea pigs		
July ...	Two guinea pigs. One crow.		
August ...	Two guinea pigs. Three dead parrots One 7-foot rat snake; disgorged later.	December ...	One palm rat. One parrot. One wagtail. One rat. One guinea pig.

1928

January		...	One rat. One enormous dead bandicoot. One dead roller. One guinea pig. One crow.
February	8	...	One guinea pig.
,,	15	...	One dead crow.
,,	24	...	One dead crow. One dead guinea pig. One big rabbit.
,,	27	...	One dead rat.
,,	28	...	One live rat. Two dead rats.
,,	29	...	One dead rat. One pariah kite (*Milvus govinda*).
March	15,	...	One Brahminy kite.
,,	18	...	Two crows.

Remarks on Diet

For the benefit of readers who have not observed the ways of pythons, a few remarks may be made.

Pythons, unlike working men, do not require two good meals a day to keep them fit; they can do without food for long periods extending over many months, and are none the worse for a prolonged hunger strike. They live on their reserves of fat.

Pythons always kill their prey before eating it. They eat it dead. Under the heading Diet, where the word dead occurs, understand that the prey was already dead before it was thrown to the python. The birds had been shot for museum purposes, but were damaged and useless. The rats and palm rats had been killed in traps. One sparrow was actually stinking.

The five rats mentioned as forming one meal in November were members of a party of nine which the cooks discovered in a cupboard and slew. I picked out the five big ones and dropped them, in a speculative mood, into the box at 8 p.m. The python began to feed at once. By morning all the five had disappeared.

In August 1927 a full grown palm civet was thrown into the box. The python killed it but did not eat it.

In December 1927 the python seemed to have become fastidious in its tastes; or perhaps its appetite for dead rats was satiated by

the November orgy. It refused two dead rats, a dead bandicoot, and a dead crow. In January 1928 the appetite was normal again.

The rat snake mentioned in August 1927 was not eaten, as sometimes happens, by a miscalculation. The python was the original sole occupant of the box. The rat snake, a gorgeous yellow black-barred specimen which I had destined for the Museum collection, was put into the same box to await execution. I knew by then that the python was a good feeder, but it never dawned on me that it might be cannibalistically inclined. There was no prey of any kind in the box, so the meal was not an accident such as is known to happen when two snakes seize a prey by opposite ends and neither lets go in time. The rat snake was put into the box at 11 a.m. The meal was about over at 1.30 p.m. when my taxidermist came to call me. A few inches of the rat snake's tail projecting from the python's mouth and still wriggling feebly was all that was still visible. At 6 p.m. the rat snake was still inside the python when the Museum workshop was closed. At 6 a.m. the following morning the rat snake was back in the box, discoloured ; and the python was coiled up in a corner—as you were.

In September 1927 I tempted the python with another rat snake. Nothing happened, the two lived on the best of terms till I removed the rat snake a week later.

In January 1928 I put another rat snake with the python ; (the rat snake laid twelve eggs). The two snakes seemed to get on well together. A week later, January 25, the python sloughed. The next day I put a guinea pig into the box ; then a strange thing happened. The python coiled its tail round the guinea pig and held it ; then it fastened its teeth in the rat snake, got it within its folds and killed it like any other prey. It then killed and devoured the guinea pig. I content myself with thus indicating the fact ; I leave it to the animal psychologist, if any such exist, to explain what passed through the python's brain when it saw the guinea pig ; and when it had killed the rat snake. It did not eat the rat snake.

It will be seen that this python is an unusually good feeder. It takes the prey, if alive, the instant it is thrown into the box, and it does not mind a noisy crowd standing round and watching the performance.

The mixed diet has evidently agreed with it. It is as fine a specimen of its size as I have ever seen. It spends the days coiled up in a corner, but at dark begins to wander about the box feeling the wire netting with its tongue.

ST. JOSEPH'S COLLEGE,
TRICHINOPLY,
March 31, 1928.

C. LEIGH, S.J.,
Curator of the Museum.

XIX.—COMMENT ON 'THE RECORD CUBBANY MAHSEER'

With reference to the Record Cubbany Mahaseer, published on page 613 of the *Bombay Natural History Society's Journal*, volume xxxii, No. 3. I write to inform you that there is a head and skin of a Mahaseer caught by Mr. Saunderson, the particulars of which noted in the label are as follows :—

'Caught in the Cubbany river some 30 miles above Nanjangud on a hand line 400 yards in length. Its dimensions as soon as landed were as follows :—

Length including tail from nose to the end of tail	60 inches
Greatest girth	38 do.
Circumference inside lips	24 do.
Weight	130 lbs.

1870.'

MYSORE GOVERNMENT MUSEUM, CURATOR.
Bangalore,
March 13, 1928.

XX.—APHIDIDÆ OF MYSORE

In the following note on the Aphididæ of Mysore, a few of the common forms have been recorded and features of special interest described. A number of other Aphids, some of them rare and probably belonging to new species remain to be recorded. An account of them will be published on a future occasion.

It will be noticed that out of the four forms usually met with in Aphids, only two, the winged and unwinged viviparous, parthenogenetic forms have been touched upon in this note. As is usually the case in tropical countries, the true sexual, oviparous forms appear to be absent in Mysore, although, these forms have been observed in parts of India, which enjoy a temperate climate and where snowy winters occur.

Confirmation of my identifications and a few other determinations have been obtained from Mr. F. V. Theobald, Agricultural College, Wye, Kent, and Mr. P. M. Mason, of the United States Bureau of Entomology, to whom I tender my acknowledgments. Finally I desire to acknowledge the encouragement and help given to me by Dr. Coleman, the Director of Agriculture in Mysore, and by Dr. Kunnhi Kannan, Entomologist.

1. *Aphis gossypii*, Glover

Theobald (African Aphididæ, *Bull Ent. Research*, vol. iv, 1913-14, p. 322) states that this species is subject to great variation in colour ranging from pale greenish-yellow to almost black. The prevailing colours in Mysore are as follows :—

Young ...	Yellowish
Pupa ...	Brownish.
Apterous female ...	Green or pale green.
Alate female ...	Thorax, black ; abdomen, pale yellow or greenish-yellow.

Das (The Aphididæ of Lahore : 1918) has stated that this species shows more distinct mottling than others. This is so in Mysore. The pattern on the abdomen of the alate female, however, differs from that he has noted. There are present black streaks in the middle of 1st to 4th, abdominal segments ; a central large black patch on the 6th, 7th and 8th segments and a rectangular patch above the anal plate on the ventral surface. Das also mentions that the sensoria on the III antennal article number from 6-8 but usually

there are 7; here a few varieties, e.g., on *Guyava*, show only 5–6. Some apterous females of this species in Mysore, e.g.,those on *Shorea talura*, have longer, and those on *Solanum nigrum*, have shorter antennæ than the antennæ of corresponding alate females. Usually, also, the alate females are smaller in size and more delicate, whereas the apterous females are big and stout.

Some individuals of this species, occurring on *Solanum nigrum* in Mysore, show the presence of lateral tubercles not only on the prothorax and 1st and 7th abdominal segments, but also on 2nd, 3rd and 4th abdominal segments.

Host plants.—A. gossypii in Mysore has been found to occur on the following plants, almost all the year round :—

Shorea talura (Jalari), *Psidium guyava* (Seebè), *Hibiscus rosa-sinensis* (Dasala), *Ocimum sanctum* (Tulsi), *Butea frondosa* (Muttuga), *Solanum nigrum* (Kari-Kachi), *Solanum melongenum* (Brinjal), *Tectona grandis* (Teak) *Capsicum fluoscence* (Chillies), *Gossypium herbaceum* (Cotton). Only occasionally this insect assumes the status of a minor pest on cotton and brinjal.

2. *Rhopalosiphum pseudobrassica*, Davis

This insect has been found in Mysore, in conjunction with another, viz. *Myzus persicæ*, Sulz., which is the common species present on tobacco and cabbage.

Das (Aphididæ of Lahore: 1918) has named anew the Aphis collected on mustard and called it *Siphocoryne indobrassica*. The mustard aphis in Mysore differs from Das's new species only very slightly and also nearly coincides with *Aphis pseudobrassica* of Davis. It is probable that the mustard aphis of Mysore is identical with *Siphocoryne indobrassica*, Das, of which, possibly, Mason was not aware.

Host plant.—Brassica nigra (Mustard). The flower stalks, tender twigs and leaves are usually heavily infested. In cases of severe attack, curling and discolouration of leaves and a decidedly unhealthy look of the plant as a whole have been noticed. *R. pseudobrassica* is found mostly during the monsoon months.

3. *Aphis maidis*, Fitch

The general body colour of this insect-green, and the elongated narrow body, specially that of the apterous female and small long brownish cornicles (Longer in apterous than in alate females) are especially characteristic in Mysore. This same insect has been found by Das on wheat, maize, oats and others.

The two branches of the cubitus of the fore wings are very short. The III antennal article bears usually 14–15 and the IV article 4–5 secondary sensoria. This seems to be a rare feature among the more commonly occurring species of Aphis here.

Host plant.—Eleusine corucana (Ragi). The crop in the field has not so far been noticed to be seriously affected; but ragi grown in the pot culture house in the laboratory has more than once been observed to be badly infested and the plants had to be sprayed in time to prevent serious damage.

4. *Pentalonia nigrinervosa*, Ckll.

Only apterous insects, and not alate ones, have yet been noticed in Mysore. Colonies occur inside the rolled-up tender leaves of *Musa*, specially during the monsoon months. A few differences from Baker's description of the genus *Pentalonia* have been noted. The cornicles show little constriction in the middle but the distal extremity is swollen. The frontal tubercles do not seem to be *Myzus*-like and they do not converge so much as in *Myzus* and the hairs present on the tubercles of *Myzus* are absent here.

The abnormal wing venation which is said to be peculiar to this insect could not be observed here, as winged individuals were not found.

Das has not mentioned this insect.

Host plant.—Musa sapientum (plantain).

5. *Aphis rumicis*, Linn.

Both the alate and apterous individuals, along with the young ones of different stages, are covered in varying degrees, with a whitish meal in such a way as to present distinct patterns on the surface, this being especially so in the adults, A few young ones of 2nd or 3rd moults did not show the presence of the meal, but looked ferruginous brown. Unlike *Aphis medicaginis*, Koch, found on other leguminous plants, this insect has a more pronounced, greenish tinge on the abdomen. The alate female is also brownish at the sides. The apterous females have a shining appearance.

This insect occurs very commonly in Mysore, densely covering leaf and fruit stalks and also the fruits, of the plants attacked.

Host plant.—Vigna catiang (cow-pea) ; almost all the year round.

6. *Toxoptera aurantiæ*, Boyer

This insect seems to occur only rarely in Mysore, having so far been noticed only once, in 1921 during the monsoon season.

In Great Britain, Europe and America, this has very generally been found on orange but so far in Mysore it has not been found on orange or any other Citrus variety. Neither has Das collected this on orange in Lahore.

The only other Toxopteran species found here till now is on *Dalbergia sissu* and that is different from *T. aurantiæ*.

Altogether, the genus *Toxoptera* is represented in Mysore very poorly and probably by very few species in the whole of India. Das has noted only 3 species, namely *T. graminum*, Rond, *T. cyperi*, V. D. Goot, and *T. punjabipyri*, Das.

Host plant.—Albizzia odoratissima (Bilvaradamara).

7. *Aphis medicaginis*, Koch.

This insect, described by Das as occurring mostly on leguminous plants, has been said to be warm reddish-brown in colour (specially apterous females). But here the apterous female of the same species is deep bluish-black or green, the alate female having a greenish abdomen, brown thorax and head with antennæ, tibia, cornicles and cauda, pale green, and coxa of legs brownish. There are 6–7 sensoria on the III antennal article of alate female, whereas

Das mentions only 5–6. There is much shining of the body in sunlight in apterous females. The latter are also very stout.

Host plant :—*Dolichos lablab* (Avare), *Crotalaria*.

On lablab, the insect is found almost all the year round, more so on the climber variety, where it occurs in dense colonies doing serious damage.

8. *Aphis tavaresi*, Del Guercio.

This species has not been recorded by Das in Lahore. He mentions *A. malvas* as occurring on the same food plant (*Citrus*).

The chief varieties of *Citrus* on which this insect is found in Mysore are :—

Citrus aurantium, (limes and oranges).

Heavy infestation is occasionally noticed after the rains and after new shoots are put forth. The honey-dew of the vast number of the individuals covers the leaves, facilitating the growth of the black fungus (*Capnodium brasiliense*). Usually the more tender parts of the plants are most subject to infestation.

9. *Aphis nerii*, Fonsc.

This yellow Aphid, with dark cornicles and cauda and red compound eyes, is common in Mysore. Das has found it in Lahore on many host plants, but here it has been observed till now only on *Calotropis gigantea* (Yukka).

10. *Aphis sacchari*, Zehnt.

This insect has been listed by Das in his 'Aphididæ of Lahore.' In the foot-note in connection with *A. sacchari*, Van der Goot says that he has placed *A. sacchari* in a new genus called *Longiungis*. Baker, in his Bulletin, has put down *Longiungis* as only a synonym of *Aphis*.

Host plant :—*A. sacchari* has been found in Mysore only sparingly on *Sorghum vulgare* (Jola); only apterous forms have so far been found.

11. *Therioaphis ononidis*, Kalt.

The Aphid occurring on the same host plant as the one named below has been described by Das in his volume under *Callipterus trifolii*, Monell.

A few differences in structural characters have been observed in *T. ononidis* occurring in Mysore. There are only seven oval (not sub-circular) double-ringed sensoria on the III antennal articles of both a late and apterous females. The cauda is knobbed and projects beyond the anal lobes which are not entirely divided but only bilobed; the anal lobes are not long and narrow but short.

Host plant :—*Medicago sativa* (Lucerne). Lucerne is the sole foodplant on which this insect has been collected both in Mysore and in other parts of India. This must, no doubt, be the same as the well-known clover-aphis of the Western countries.

12. *Myzus persicae*, Sulz.

This insect has sometimes been found in combination with *Rhopalosiphum pseudobrassica* on mustard.

Host plants:—*Nicotiana tabacum* (Tobacco), *Brassica oleracea* (cabbage).

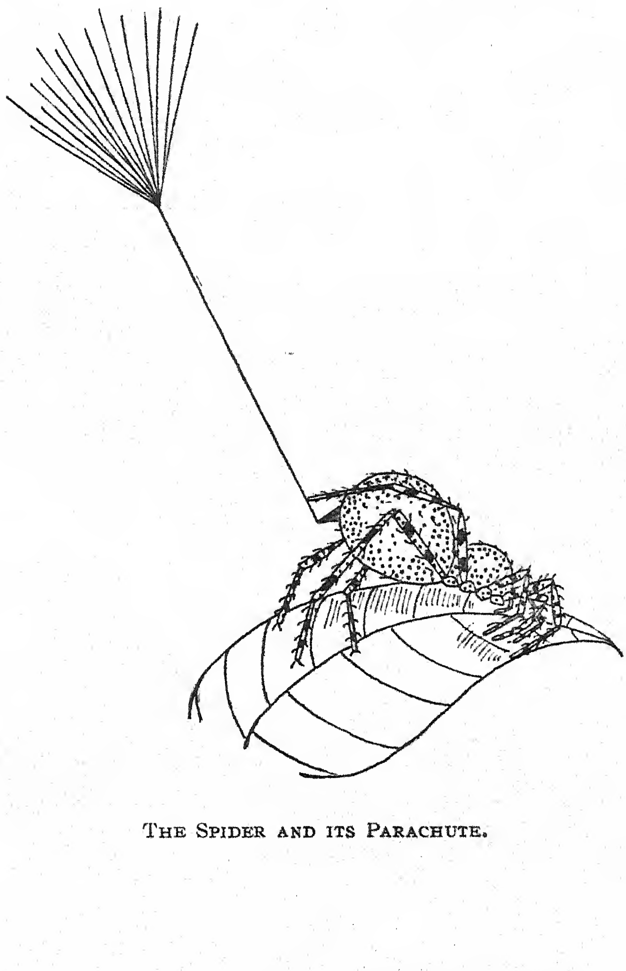
Whenever these are grown in Mysore, the colonies of *M. persicæ* are found on both surfaces and in and around tender curled-up leaves. On tobacco, specially, it has very often become a serious pest with the result that a number of cultivators in Mysore have regularly requested spraying with fish-oil-resin soap or tobacco decoction.

B. KRISHNAMURTHY, B.SC.
Assistant Entomologist, Department of Agriculture, Mysore.
BANGALORE.

XXI—'MIGRATION' OF SPIDERS

(*With a text-figure*)

It was a hot day towards the end of summer in Mesopotamia as I lay under a date-palm just outside the precints of a desert town,



THE SPIDER AND ITS PARACHUTE.

some twenty miles from Basra, and idly watched a spider near at hand. He seemed to spin out a web which clustered together in the form of a cluster of balloons, tilting his abdomen well over in so doing. Then he spun out a single thread and with a distinct wink at me, took off into the air!

It was only on looking up that I discovered several other 'aviators' with their parachutes rapidly diminishing from sight but all drifting southward. Were they migrating to warmer lands with the advent of winter? How would they adjust their parachutes if they wished to descend? Perhaps some of our readers could give us a few interesting pointers on this subject.

V. S. LaPERSONNE.

BOMBAY NATURAL HISTORY SOCIETY,

6, APOLLO STREET.

February 20, 1928.

[We are indebted to Major R. W. G. Hingston for the following note concerning the spider and also for the excellent sketch here reproduced. He writes: 'Your request for comments on Mr. LaPersonne's observation reminds me that I noticed the same phenomenon in Mesopotamia during the war. I can therefore supply you with the following information taken from my notes made at that time.

The dispersal of spiders through the agency of wind takes place in Mesopotamia on a profuse scale. When the wind blows from the north the air is sometimes full of spider's silk. It is not just small fragments, but often large matted flakes or layers that seem to descend from higher strata, and, as it were, rain on to the earth. At times the dispersal is so profuse that we may regard it as a dense migration of spiders. The gossamer swept by this northerly wind gets entangled in everything it touches. Often it streams from plam trees and telegraph wires in waving flags of silk.

The young of many kinds of spiders have the habit of shooting out a filament of silk and drifting on it for long distances through the air. The act serves to disperse the species. Mr. LaPersonne inquires as to the mechanism of this parachute. I have not been able to solve it with certainty, for I have not yet seen the extreme tip of the first thread given out by the young spider. But I have the strongest reason for thinking that the mechanism is the same as with the first thread that a spider employs in making its snare. Now, this is not a simple thread, but one which ends in a kind of brush or rather pencil of most delicate fibrils. The breeze catches in this tuft and pulls the line from the spider's spinnerets. I suspect the same mechanism in the gossamer spider. The breeze sweeps the tuft through the air, while the spider hangs suspended from it, as it were from a balloon. These tufts are what Mr. LaPersonne calls parachutes. How does the young spider manage to descend? I imagine by hauling the line in with its legs, an act spiders are well able to perform.' EDS.]

ANSWERS TO CORRESPONDENTS

Questions from readers of the Journal will be answered on this page. It is hoped that the introduction of this feature will establish a more direct connection between the Society and its members.

Venom of Snakes

A. T.—The primary function of snake venom is to overcome the prey. Secondarily the venom acts as a digestive fluid and confers on the snake immunity against its own poison and the poison of other venomous snakes.

It should be understood, however, that immunity is not an absolute property but is conditioned by the amount of poison innoculated and the mode of injection. In this sense a Cobra is immune from the venom of the Russell's Viper because no viper can at a bite inject enough venom to kill a Cobra.

Snake-venoms are very complex liquids which we cannot differentiate chemically. We distinguish various types of snake poison by their effects on animals especially selected for the purpose. Now, as different animals respond differently to the same venom, our classification has no other value than that of convenience.

Immunity depends upon a number of different factors: presence of antitoxins in the serum of the victim, special resistance of tissues, protective layers (slightly vascular fat), physiological antagonism, and the absence of actuators or of receptors.

Iguanas

A. P. M.—No Iguanas occur within the Indian region. The family (*Iguanidæ*) is chiefly American with representatives in Madagascar and Fiji. The largest and best known of these are found in the forest regions of Tropical America. Some are aboreal, others terrestrial or burrowing, and one, the Marine Iguana (*Amblyrhynchus cristatus*) of the Galapgos Islands lives on the rocks of the shore and feeds on sea-weed. In India the term Iguana is usually applied to the Monitor Lizards of the genus *Varanus*, of which four species occur within our limits. Monitor Lizards are the largest of all lizards some exceeding a length of six feet. The Dragon Lizard of Komodo which has received so much attention recently, belongs to this genus. Monitors differ markedly from the typical aboreal Iguanas both in shape and colouring. The body of the Monitor, like most terrestrial lizards, is flat and depressed, while that of the Iguana like other aboreal lizards is narrow and compressed. The name Monitor or Warning Lizard is said to be derived from a confusion between *Ouaran* the Arabic term for Lizard and the English word 'warning'.

Poisonous Lizards

F. H.—This is a question which crops up repeatedly. As far as hitherto ascertained no Indian lizard is poisonous. A belief in the venomous nature of many common species of lizards persists and is prevalent throughout the country. In addition to the common and harmless House Geckos or 'Fly Catchers', which are found in almost every house in India, the skinks, particularly the Common Skink (*M. carinata*), which one sees scuttling over the ground with a sinuous snake-like movement, the Fat-tailed Lizards (*Eublepharis*), which occur in the drier portions of Western and North-Western India and last but not least the young of various species of Monitors (*Varanus*), one of the many harmless lizards which have been branded as the genuine 'bis cobra',—all these are vested with highly poisonous properties. The belief in poisonous lizards is by no means confined to India. It may be safely said that there is no known species of lizard in India which is provided with glands for secreting venom or fangs through which to eject it, nor are there any lizards in India whose dentition is in any way suspicious.

The Brain-Fever Bird

H. M. Mc. G.—There are various aspirants to the title. Among other cuckoos we have heard the term applied to the Common Koel whose persistent and irritating vocal efforts have been translated to express in a crescendo of emotion his conviction 'you're ill, you're ill.' But it is commonly agreed that the unpleasant title should go to the Common Hawk Cuckoo (*Hierococcyx varius*) a bird with grey upper plumage, a rufous breast and a barred tail and underparts. Its rapid loud and piercing call 'pi-*pee*-ah' with a decided accent on the second syllable may be heard by day or by night in any part of India during the hot weather particularly during May and June when these birds are busy cuckolding various Babblers and Thrushes on whom they confer the unsolicited privilege of caring for their eggs and upbringing their offspring.

'Flame of the Forest'

G. R. E.—Some take it to be the well-known Royal Gul-Mohur (*Poinciana regia*, Boj.), others *Butea frondosa*, Konig.

The Gul-Mohur is a native of Madagascar and has been introduced into India about 100 years ago. Mr. W. S. Millard remembered Birdwood maintaining that the Flame of the Forest was the name for *Poinciana regia* in the Madagascar forests. But in his Catalogue of the Flora of Matheran and Mahableshwar (1887, p. 11) Birdwood calls *Butea frondosa* 'Flame of the Forest'. The fact alone that *Poinciana regia* is not a forest-tree in India makes it very unlikely that anybody should have thought of calling it Flame of the Forest. But anybody who has seen *Butea frondosa* cannot help being struck by the resemblance of its flowers to flames, whilst the Gul-Mohur can scarcely produce that impression.

If we are not mistaken J. D. Hooker was the first to mention that resemblance. Lindley and Moore (*Treasury of Botany*, part I, ed. 1899, p. 183) refer to him when they say: 'Dr. Hooker states that

when in full flower the Dhak tree (*Butea frondosa*) is a gorgeous sight, the masses of flowers resembling sheets of flame, their bright orange-red petals contrasting brilliantly against the jet-black velvety calyx.'

Nairne was similarly impressed when he wrote about *Butea frondosa* (*Flowering Plants of Western India, 1894*, p. 88) : 'In the Panch Mahals, where it is common and attains a better size than in any other district I know, it very frequently grows out of the hollow trunk of a wad tree, and gives a character to the whole landscape in the cold weather having

> 'Flowers that with a scarlet gleam
> Cover a hundred leagues, and seem
> To set the hills on fire.'
> (*Wordsworth*).

Nairne does not seem to have known the name of 'Flame of the Forest,' but we come across it in Troup (*Silviculture of Indian Trees* 1921, vol. i, p. 258): 'The blackish flower-buds appear on the bare branches in January and from the end of that month and through February and March the trees herald the hot weather by bursting forth in a blaze of scarlet blossoms, presenting a gorgeous sight which if once seen can never be forgotten: the tree is on this account appropriately termed the "flame of the forest".'

PROCEEDINGS

Of the Meeting held on July 18, 1928

A meeting of the members of the Bombay Natural History Society and their friends took place on Wednesday the 18th instant at the Prince of Wales' Museum at 6.30 p m., Mr. R. D. Bell, C.I.E., I.C.S., presiding.

Mr. P M. D. Sanderson announced the election of the following fifty-two new members since the last meeting: Mr. Alexander Henderson, Bombay; Mr Andrew B. Porteous, Nagvas, B. B. & C. Ry.; Mr. H. M. McGusty, Bombay; The Honorary Secretary, Anamallai Game and Fishing Association, Valparai P.O., S.I., Mrs. D.J. Greaves, Bombay; Mr. F. Clifton, Bournemouth, England; Mr. C. E. M. Judge, Delhi; Mr. Ali Mahomed Mecklai, Bombay; Mr. Amir Shaikh Mohamad, Junagadh; Mrs. Leona Starr, F.R.G.S., Colombo; Lieut. A. E. Brocklehurst, R.A., Bangalore; Raja Gajendra Shah of Khutar, U.P.; Mr. W. S. Cassels, I.C.S., Lucknow; Mr. B. A. Parr, Bombay: Mr. R. L. Scott, Renfrewshire, England; Mr. H. G. Dalton, Perak, F.M.S.; Mr. G; St. John Cowper, Bombay; Mr. A. D. Shanks, Bombay; Mr. Kaikobad B. Marzban. J.P., Bombay; Mr. DeWet Van Ingen, Mysore, S.I.; Mr. E. R. Davidson, R.A.S C., Baghdad; Mr. W. F. Grahame, I.C.S., Meiktila; Mr. C. D. Claudius, Insein; Mr. E. Walsh, Bombay; Mr. James L. Smyth, N. Coorg; Major S. S. Sokhey, I.M.S., Bombay; Mrs. H. G. Cocke, Bandra, Bombay; Mr. H. S. George, I.F.S., Chikalda, Berars; Mr. A. C. Harman, Champaran; Mr. R. L. Piggott, Kadur; The Director, Carnegie Museum, Pittsburgh, Pennsylvania, U.S.A.; Mr. J. H. Methold, Calcutta; Mr. R. Pattison, Bombay; Mr. Wilfred Laws, Assam; Mr. W. J. Moloney, Bombay; The Director of Museums, Straits Settlements and F. M. States Museum, Kuala Lumpur; Mr. M. T. Graham, Bareilly, U.P.; Mr. David Boyle, Travellers' Club, London, England; Mr. C. E. Allan, Abu Road; The Principal, Assumption College, Bangkok; Mr. J. A. Yates, Bangalore, Mr. J. H. Dauglish, Coimbatore, S.I.; Mr. C. E. C. Cox, I.F.S., Amraoti; Capt. C. W. L. Harvey, M.C., Mt. Abu; Lieut. R. K. M. Battye, R.A., Mhow; The Zoologisches Museum der Universitat, Berlin, N. 4.; J. M. Caldwell, Tung; Mr. E. W. Maude, Lebong, Darjeeling; Mr. T. H. Newman, F.Z.S., M.B.O.U., Wembley Park, England; Sir Fairless Barber, Calicut; and Mr. A. U. Pullan, Kurseong.

He outlined the progress made by the Society and spoke of the efforts that were being made to make the Society's Journal more attractive to its readers. In addition to the serial on Indian Game Birds by Stuart Baker, the Society hoped shortly to bring out a series of articles on the commoner Flowering Trees of India, illustrated in colour and this serial would, he was sure, make a wide appeal, particularly in view of the absolute dearth of readable books on a subject which interested a great number of people in India.

Exhibition of Paintings

Members were given an opportunity of inspecting a beautiful series of paintings of Indian forest scenes, made during the Vernay-Faunthorpe Expedition. The artists, Mr. C. C. Rosenkranz of the American Museum, New York, and Mr. K. B. Savardekar of the Prince of Wales' Museum, Bombay, have produced excellent work which will be used in the Museums in New York and Bombay, in the construction of large habitat groups illustrating the animal life of this country. One of these groups is now being built in the Prince of Wales' Museum and will be opened to public exhibition before the end of this year.

Our Insect Orchestra

Mr. S. H. Prater, the Society's Curator, delivered an interesting lecture on Our Insect Musicians and their Instruments. The Monsoon is the season when our insect orchestra is heard at its best. The whole air at dusk seems to tinkle and murmur with a medley of sound produced by its musicians. They are all

members of four insect families :—The Short-horned Grasshoppers, the Long-horned Grasshoppers or Katydids, the Crickets and the Cicadas. The Short-horned Grasshopper is a fiddler. His fiddles are his front wings and his bows are his hind legs. On the inner side of each hind thigh certain grasshoppers carry a ridge armed with fine teeth which is scraped against a sharp-edged vein on the forewings. This produces his chirping note. The finest insect musicians are to be found amongst the Long-horned Grasshoppers or Katydids. Katydids are the *virtuosos* of the insect orchestra. Their musical instruments are carried on the bases of their front wings. The right wing carries a drum and a sharp ridge ; the left wing bears a file, which is used as a bow to play on the ridge on the right wing, the bow scrapes on the ridge and the tone and volume of the sound is controlled by vibrations set up in the drum. The instruments of the crickets are much the same. The details of construction and the methods of sound production differ. The loud notes of the cricket are produced by the rapid vibration of the uplifted wings. The right wing usually working over the left, the edge of one acting on the file of the other to give out a shrill long-sustained note. The musical instruments of the cicadas are the most marvellous sound producing organs in the animal kingdom. On the underside of his body the cicada carries a pair of drum heads generally protected by flaps, set in solid rims of the body wall. The cicada does not beat his drums. They are set into intense vibration by a pair of great muscles attached to them from within the body. Air cavities and accessory vibrators beneath these drums help to increase or diminish the sound which is also influenced by the hollow abdomen and the position of the covering flaps. Why do insects sing ? In some cases it is to attract or advertise their presence to the female of the species. In the majority of insect performers the females are dumb. They are relegated to the role of appreciative listeners. This discovery caused Xenarchos, a Greek poet to exclaim 'Happy the cicadas' lives for they have voiceless wives.' Again it would seem that in many cases the voice of the insect is the voice of Mirth--an expression of his feelings, an outlet for pent-up emotion ; like unto the voice of a man singing in his bath, and it is certain that no sane man hopes to impress his wife by the performance ! The lecture was illustrated with a helpful series of lantern slides.

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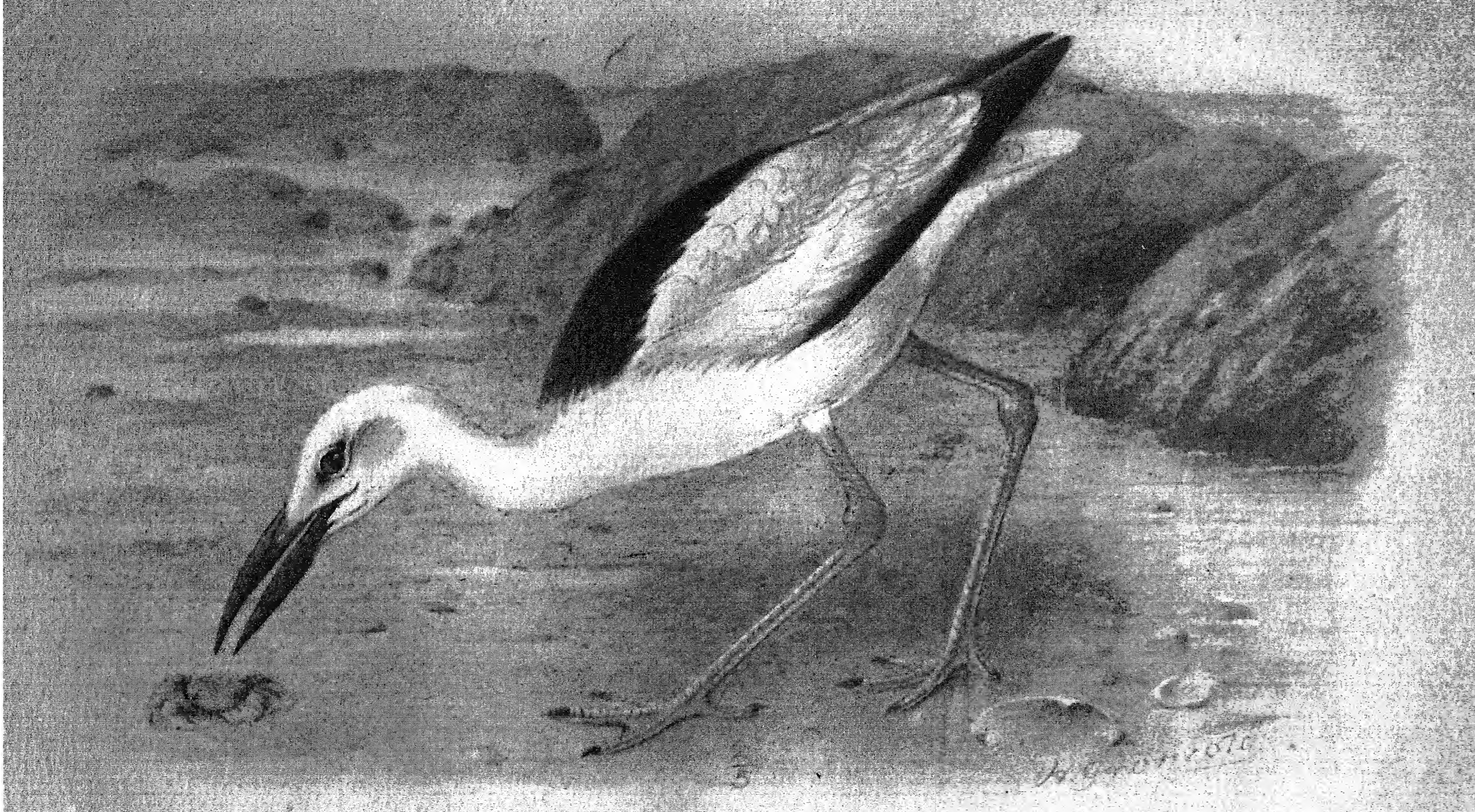

THE CRAB-PLOVER
Dromas ardeola
⅖ Nat. size.

JOURNAL

OF THE

Bombay Natural History Society

JANUARY, 1929 VOL. XXXIII NO. 2

THE GAME BIRDS OF THE INDIAN EMPIRE

BY

E. C. STUART BAKER, F.Z.S., F.L.S., M.B.O.U., H.F.A.O.U.

VOL. V

THE WADERS AND OTHER SEMI-SPORTING BIRDS

PART VIII

(*With a coloured plate*)

(*Continued from page 6 of this Volume*)

FAMILY.—HELIORNITHIDÆ

This small but remarkable family is undoubtedly very closely related to the *Rallidæ* from which, however, it differs in many important respects.

In the Fin-foot the toes are furnished with a lobed fringe very similar to that of the Coots; the sternum is more massive, broader posteriorly with a shallow notch on each side; there is no aftershaft; the wing is quincubital in our Indian species; there are no bare tracts on the neck; rectrices eighteen.

The flexor tendons are peculiar and appear to be a modification of the Galline arrangement. The *flexor longus halucis* gives off a slip to supply the hallux and is then divided into three, each branch uniting with a similar branch from the *flexor perforans digitorum* to supply one of the other three toes.

The family contains three genera of which one only is found in India.

Genus: HELIOPAIS

Heliopais Sharpe, Bull. B.O.C., vii, p. xxxvii, 1893.

Type by mon. *Heliopais personata* Gray.

Bill from gape longer than tarsus and rather stout ; culmen considerably curved ; no frontal shield but in the breeding season there is a small fleshy horn from the base of the culmen ; nostril long and narrow, pervious and placed nearly in the centre of the upper mandible ; tarsus shorter than middle toe without claw but very strong ; toes fringed with a lobed web ; wing rounded, the second, or second and third longest, the first equal to fifth or sixth ; rectrices, eighteen in number, broad and stiff, slightly graduated and equal in length to about half the wing.

Sexes slightly differing.

HELIOPAIS PERSONATA

The Masked Fin-Foot

Podica personata Gray, P.Z.S., 1848, p. 90, Malacca.

Heliopais personata. Blanf. and Oates. iv, p. 182.

Vernacular Names.—Ye Balon (Burma).

Description :—Male. Forecrown running back in a line over the earcoverts, face, chin, throat and foreneck velvety black, the forehead and the rest of the black, except on the crown, surrounded by a narrow line of white ; posterior crown and hind neck steel grey, the crown with metallic reflections ; sides of the neck, interscapulars and upper back light olive-brown, each feather with a metallic green edge ; lower back, wings and tail light brown grading from the olive brown ; the upper tail coverts rather paler brown ; tail narrowly tipped with whitish ; breast and abdomen white ; flanks brown, barred with white next the abdomen ; under tail-coverts barred brown and white.

Colours of soft parts.—Iris dark brown ; eyelids pea-green ; bill bright chrome yellow shaded with brown in the centre ; legs and feet pea-green, the edges of the web yellow ; in Summer the horn is highly developed, erectile and bright yellow in colour ; in Winter it shrivels up and disappears.

Female.—The white line on the forehead broader ; chin, throat and foreneck white, surrounded by black which is edged with white as in the male ; the black frontal band is less broad.

Colours of soft parts as in the male but much duller whilst the iris is yellow ; there is no horn.

Measurements.—Wing, ♂ 248 to 183 mm.; ♀ 232 to 241 mm.; tail 98 to 124 mm. ; tarsus 36 to 51 mm. ; culmen, ♂, 52 to 56 mm.; ♀ 41 to 50 mm.

Young birds are like the female but have no black on the crown, whilst that surrounding the throat is mottled with white.

Distribution.—Eastern Assam, Bengal, North and East of the Bay of Bengal, Burma and Malay States to Sumatra.

Nidification.—Dr. Gregerson took the first authentic nest of this bird in Assam on the 24th July but the young had hatched with

the exception of one infertile pigmy egg. In 1920 and subsequent years Messrs. Smith and Marlow obtained numerous nests in the flooded country of the Tharrawaddy District of Burma during the months of July and August. These latter nests were made of sticks and twigs lined with leaves and were rather massive structures of about 15″ in diameter by 6″ to a foot in depth, the egg cavity being about 8″ across and 2″ deep. They were all placed on tangled branches of trees or shrubs, in one case only a few inches above the water, in other cases as much as nine feet, whilst, in every case, the sites selected were in flooded forest. The country where they nest is of the wildest character but the birds, which are very numerous, seem often to breed in the vicinity of the few villages which are dotted about in the jungles on the higher ground. They sat very close and would allow Mr. Marlow to get within a few inches before leaving the nest. The eggs number five to seven and are *sui generis* though distinctly Ralline in character. In shape they are very spherical, though more oval specimens may be seen occasionally. The ground colour is a very pale cream, in one or two clutches faintly tinged with pink. The primary markings consist of fairly larger reddish-brown blotches very sparsely scattered over the whole surface, sometimes rather more numerous at the larger end. Under these are secondary markings of lavender grey, distributed like the others, sometimes more numerous, sometimes less.

Habits.—The Masked Fin-Foot is a bird about which remarkably little was known and practically nothing recorded until Hopwood sent to this journal an account of the results of Messrs. Marlow's and Smith's discoveries in Lower Burma. In some parts of Assam it was by no means uncommon and was known amongst the tea planters as 'The Running Duck'. During the Winter as well as during the breeding season, however, it kept entirely to the most impenetrable swamps between the foot-hills of the Himalayas and the Brahmapootra River. In this land of desolation where nobody ever entered except a few elephant-catchers or an odd company or two of rubber collectors, the bird passed its life in infinite peace. For many weary miles in every direction there was nothing but the densest of forest interspersed with endless shallow swamps. In some places muddy slow-trickling waterways would run for some miles to be once more lost in the swamp, forming practically the only means of moving about in such country. Here the Fin-Foot was comparatively common and safe from molestation, but in the early Spring and late Autumn they were in the habit of following the courses of the various streams out into the open and were then occasionally seen and shot.

In Lower Burma, Messrs. Smith and Marlow found them very common on the upper reaches of the Rangoon River and Mr. Hopwood estimates that there were at least 500 pairs breeding during the rains in this country, which seems to be very similar to that already described above. In this part of Burma the bird is known as the Water Bubbler, *Ye Balon*, this name being given to it on account of the bird's call which is said to be similar to the sound of air being blown through a tube into water. When undisturbed, the

Fin-Foot is very tame and confiding and in these circumstances its normal position when swimming is very high in the water, but when frightened it submerges all but the head and neck. In both swimming and diving it excels the Coot whilst on land it runs at an extraordinary pace and frequently to escape danger it retreats on foot into the nearest jungle rather than escape by swimming and diving. Its flight is essentially Coot-like in that it rises very slowly, whether from land or water and for some time carries its legs hanging low behind it. When once well away, however, its flight is more like that of the Duck than the Coot. Their diet appears to be partly vegetarian, insectivorous and fish. I have never heard it utter any sound other than the bubbling call referred to by Mr. Hopwood. They are highly esteemed by the natives as an article of food and their eggs also are regularly hunted for by the Burmese people living where they breed.

FAMILY.—DROMADIDAE

Genus: DROMAS

Dromas Paykull, Svensk K. Vet.—Ak. Nya Handl., xxvi, pt. 3, p. 182 (1805).

Type by mon., *Dromas ardeola* Paykull.

Bill longer than the head, strong, smooth and compressed; culmen regularly curved; no groove, the nostril being placed in a small depression near the base of the bill; the angle of the lower mandible prominent and close to the base; wing long and pointed, the first primary longest; tail very slightly graduated; tarsi long, shielded in front and behind; half the tibia bare; toes long, the third and fourth joined by a broad web, the second and third by a small one; middle claw broadened and pectinated or notched on the inner dilation; feathers of interscapulary region lengthened and covering the back.

DROMAS ARDEOLA

The Crab-Plover

Dromas ardeola Paykull, Svensk, K. Vet.—Ak. Nya Handl. xxvi, pt. 3, p. 182, pl. 8 (1805) (India); Blanf. & Oates, iv, p. 209.

Vernacular Names.—None recorded.

Description.—Back, long scapulars and greater coverts black; primaries black on the outer webs, pale brownish on the inner and with white shafts; outer secondaries brown on the outer webs, white on the inner; angle of eye behind and before black; remainder of plumage pure white, the tail often remaining pale grey for some time after the rest of the adult plumage is attained.

Colours of soft parts.—Iris brown; bill black; legs and feet grey-white to pale glaucous-blue.

Measurements.—Wing ♂ 209 to 225 mm., ♀ 201 to 210 mm.; tail 65 to 75 mm.; tarsus 89 to 100 mm.; culmen, ♂ 55 to 61 mm., ♀ 54 to 56 mm.

Young birds have the crown and neck pale grey, the former with black shaft-streaks; back, scapulars, and wing-coverts darker grey tinged with brown, the feathers of the back and scapulars edged blackish; tail grey-brown, whiter on the inner webs of the lateral feathers.

Distribution.—From the shores of the Red Sea and Persian Gulf, all round—but locally distributed—the coast of India, Ceylon and the Laccadives.

Nidification.—The Crab-Plover commences to breed about the middle of May and odd eggs may be found in early June on the islands in the Persian Gulf and the Red Sea, but in Ceylon it does not appear to lay until late June, at which season it was found breeding on the Island of Adam's Bridge. Sir Percy Cox and Major Cheesman found immense colonies of these curious birds breeding on some of the islands in the north of the Persian Gulf, that on Buna Island consisting of several hundreds of birds. The eggs are either laid at the bottom of burrows in the sandy soil—in some cases apparently dug out by the birds themselves—or they are laid in hollows amongst the loose boulders and rocks. It undoubtedly, however, prefers burrows wherever the soil is sandy and loose enough for these to be made. They are of no great depth, being anything between a foot and four feet, the extremity where the nest is being rather larger than the entrance. Only one egg is laid but that one is enormous in size compared to the bird. In colour it is a pure white, with a very smooth close texture, but not particularly hard or glossy, whilst in shape it is a long oval, slightly pointed at the smaller end. In general appearance these eggs are hardly distinguishable from the eggs of some of the Shearwaters. Thirty average 65·4 to 45·9 mm., maxima **67·3** by **47·5 mm.**, minima **61·0** by 46·2 and 63·5 by **44·2 mm.**

The birds are said to sit very close and have in some cases to be pulled out of the hollows which they refuse to quit. Cumming, who took many nests on islands near Fao, says that the birds pecked at the hands of natives and attempted to resist being dragged off their eggs.

Habits.—The Crab-Plover is one of the birds which prove a great stumbling-block to systematists, for it is extremely hard to say where it should be placed. It has a curious head, large eyes, and stout bill, making it look as if it ought to be somewhere near the Thick-kneed Plovers, whilst it has long legs and neck and certain other characteristics which link it with the Storks, and finally its nidification is *sui generis.* It is an extremely sociable bird and always consorts in flocks of considerable size, not only in the breeding season, but also at other times and it is only when the extreme limits of its distribution are reached that it occurs in small numbers, but even in these places, such as Oyster Island off the coast of North Burma, it is always in flocks of some size and never single or in pairs. It is very crepuscular in its habits and seems to feed only in the early mornings and late evenings and, if there is a moon, all through the night. It is, of course, confined entirely to the sea coast and is never found inland, even on the brackish tidal rivers. Its food consists principally of small crabs, but it

devours all kinds of small living things, such as crustacea of all kinds, small mollusca, sea worms, etc. Whilst hunting for its food, its actions are very plover-like, consisting of constant little short jerky runs, made at great speed from one point to another, finishing up with a little jerk and a bob such as the Ring-Plovers indulge in. It flies well and fast, although it presents a very curious appearance, with its long legs stretching right behind, whilst the head is tucked in close to the shoulder. It is said to have a low, rather musical call and when disturbed on its nest the birds, both young and old, hiss at the intruder.

(To be continued)

REVISION OF
THE FLORA OF THE BOMBAY PRESIDENCY

BY

E. BLATTER, S.J., PH.D., F.L.S.

PART VIII

GRAMINEÆ

BY

E. BLATTER and C. McCANN

(*Continued from page 25 of this Volume.*)

60. CENCHRUS, Linn.; Hitchcock and Chase in Contrib. U.S. Nat. Herb. xx (1920), 50.

Annual or perennial herbs. The inflorescences are spike-like racemes, consisting of involucellate clusters of shortly pedicellate spikelets jointed on a simple rhachis. Involucel consisting of hardened spike-like bristles, connate at the base into a short, coriaceous cup, which is surrounded by erect or squarrose bristles. Spikelets 1–3 in each involucel, mostly glabrous or nearly so, persistent, 1-2-flowered, with 3-4 glumes Lower involucral glume 1-nerved, usually narrow, sometimes wanting; upper involucral glume and lower floral glume subequal, 5-7-nerved. Lower floral glume longer than the upper involucral, with or without male flower, paleate Upper floral glume coriaceous, with a hermaphrodite or female flower. Lodicules 2. Stamens 3. Styles 2, stigmas plumose. Grain broad, oblong, dorsally compressed, with a punctiform hilum, free within the glume and pale.

Species about 25.—Tropical and subtropical.

1. Base of involucel rounded ... ... 1. *C. biflorus.*
2. Base of involucel turbinate ... ... 2. *C. catharticus.*

1. **Cenchrus biflorus,** Roxb. Fl. Ind. i (1832), 233; Cke. ii, 917; Achariyar S. Ind. Grass. (1921), 121—For synonymy see Hook. f. in F.B.I. vii, 89.

Description: Cke. l.c.

Locality: Sind: Karachi (Woodrow); Jamadar ka Landa, near Karachi (Stocks); Jamesabad, in fields (Sabnis B1110!); Umerkot, sandy plains (Sabnis B1081!); Nasarpur, clayey soil (Sabnis B1051!); Mirpur Sakro (Blatter and McCann D627!); Tatta (Blatter and McCann D628!).—*Gujarat:* Kharaghoda, under trees (Saxton 1064!); Ahmedabad (Sedgwick!, Cooke); Morvi (Woodrow).—*Khandesh:* Bhusawal, Tapti (McCann 5154!); Umalla, Tapti Bank (Blatter and Hallberg 5158!); Kaperkhedo, Bori River (Blatter and Hallberg 4393!).

Distribution: Punjab, Rajputana, Gangetic Plain, W. Peninsula, Baluchistan, Arabia, Africa.

2. **Cenchrus catharticus,** Del. Cat. Hort. Monsp. (1838); Schlecht. Linnæa xiii (1839) Litt. p. 103; Cke. ii, 918; Hitchcock and Chase in Contrib. U.S. Nat. Herb. xx (1920), 53, fig. 8; Achariyar S. Ind. Grass. (1921), 122.—For synonyms see Hook. f. in F.B.I. vii, 90.

Description: Cke. ii, 918.

Locality: Sind: Karachi (Burns!); Gharo (Blatter and McCann D629).—*Gujarat:* Ahmedabad, sandy ground (Sedgwick!); Sumrasar, Cutch (Blatter 3762!); Perim Island, at the mouth of the Narbada River (Raoji).—*Khandesh:* Bor, Bori River (Blatter and Hallberg 5115!).

Distribution: Punjab, Gangetic Plain, W. Peninsula, Bellary, Nellore, Arabia, tropical Africa.

61. Isachne, R. Br. Prodr. Fl. Nov. Holl. (1810), 196 ; Cke. ii, 922.

For discussion of the genus see : Chase Genera Paniceæ. iv. Proc. Biol. Soc. Washington 24 (1911), 149 and Hitchcock North Americ. Species of Isachne in Contrib. U.S. Nat. Herb. 22 (1920), 115.
Key in Cke. ii, 922.

1. **Isachne Lisboae,** Hook. f. in F.B.I. vii (1896), 22 ; Cke. ii, 922.
Description : Cke. l. c.
Locality : Deccan : Mahableshwar, elevation 4,000 ft., rainfall 270 inches (Sedgwick and Bell 4581 !), Fitzgerald Ghat, Mahableshwar (Woodrow !), common near the lake (McCann !) ; Panchgani, First Tableland (Blatter and Hallberg !), very common on Tableland (McCann !).
Distribution : This species is very local, inhabiting apparently only the Panchgani and Mahableshwar plateaux.

2. **Isachne elegans** Dalz. in Dalz. & Gibs. Bombay Fl. (1861), 291 ; Hook. f. in F.B.I. vii, 23 ; Cke. ii, 923.
Description : Cke. l.c.—We have found specimens reaching the following dimensions : Stem 90 cm. ; leaves 25 by 1 cm., or broader, sparingly hairy or almost villous ; panicle 25 by 15 or more cm.
Locality : Konkan : Pen, in inundated land (Dalzell).—*Deccan :* Margins of rivulets in the Deccan (Dalzell and Gibson) ; Mahableshwar, elevation 4,000 ft., rainfall 270 inches (Sedgwick and Bell 4583 !) ; Panchgani, Tableland, forming, large patches (Blatter 5080 !) ; Sinhagad forest (Bhide !) ; Nasrapur to Purandhar (Bhide 1001 !) ; Purandhar, N. foot (McCann 5048 !) ; Lohagad Fort, top (McCann 9560 !) ; Khandala, behind hotel (McCann 9555 !); Lonavla (Woodrow 175) ; Ganeshkhind Gardens (Herb. Econ. Bot. Poona !) ; between Poona and Karli (Jacquemont 556).—*S.M. Country :* Dharwar, rice fields, elevation 2,500 ft. (Sedgwick 1829 !).—*Kanara :* Halyal, rice fields (Talbot 2305 !).—Usually forming large mats in damp soft soil, and then not growing very tall.
Distribution : So far endemic.

3. **Isachne australis,** R. Br. Prodr. (1810), 196 ; Cke. ii, 923.—For synonyms see Hook. f. in F.B.I. vii, 923.
Description : Cke. l.c.
Locality : Gujarat : (Lisboa).—*Konkan :* Nagotna, in dry plains (Gammie 16064 !) ; Kharda (Ryan 565 !) ; Bhandup (McCann 9841 !) ; Matunga to Mahim (McCann 9842 !) ; Andheri (McCann 5129 !) ; Sion (McCann 5244 !) ; Pen (McCann 5390 !) ; Alibag, rice fields (Ezekiel !); Mulgaum, tank (McCann 5103 !) ; Matheran, Charlotte Lake (D'Almeida A247 !).—*Deccan:* Khandala, common (McCann 9840 !) ; Sakarpathar, Lonavla (Gammie 15961 !) ; Igatpuri (Blatter and Hallberg 4308 !) ; Poona (Lisboa) ; Mahableshwar (Woodrow) ; Nasik (Lisboa).—*S.M. Country :* Dharwar District, rice fields, elevation 1,800 ft., rainfall 35 inches (Sedgwick 3737 !) ; Kunnur, marshes, elevation 2,000 ft., rainfall 35 inches (Sedgwick and Bell 4936 !) ; Londa (Bhide !).—*Kanara :* Karwar (Bell !) ; Gohann (Herb. Econ. Bot. Poona !) ; Halyal (Talbot 2160 !); Sirsi to Siddhapur (Hallberg and McCann A19 !) ; Yellapore (Talbot 1521 !) ; Kadgal (Herb. Econ. Bot. Poona !).
Distribution : All over India, Australia, New Zealand.

4. **Isachne miliacea,** Roth. Nov. Pl. Sp. (1821), 58; Cke. ii, 923.—For synonyms see Hook. f. in F. B. I. vii, 25.
Description : Cke. l.c.
Locality : Konkan : (Woodrow).—*Deccan :* Lonavla (Woodrow) ; Mahableshwar, in forests, fairly common in one spot (McCann !).—*Kanara :* Sulgeri, 500 ft., rainfall 200 inches (Sedgwick and Bell 4248 !) ; Yellapore (Talbot 1522!); Gersoppa Falls, Mysore side (McCann & Hallberg A23 !).
Distribution : More or less throughout India, Ceylon, China, Malay and Pacific Islands, S. America.

62. Arundinella, Raddi Agrost. Brasil. (1823), 37 ; Cke. ii, 999.
Species about 55.—In the tropics.
Cooke describes 12 species from the Bombay Presidency. We retain them all except that we change *A. agrostoides,* Trin. into *A. ciliata,* Nees, and *A.*

brasiliensis into *A. hispida*, O. Ktze. To the 12 species we add another: *A. villosa*, Wight & Arn.

Key after Cke. ii, 999.

A. Upper floral glume with 3 awns.	
I. Leaves less than 10 cm. long Annuals	
1. A straggling grass. Leaves glabrous or sparsely hairy...	1. *A. avenacea.*
2. An erect grass. Leaves hispid with bulbous-based hairs	2. *A. tuberculata.*
II. Leaves 15–30 cm. long. Perennials ...	3. *A. setosa.*
B. Upper floral glume with 1 awn	
I. Spikelets 1·5–2 mm. long	4. *A. tenella.*
II. Spikelets 2·5–3mm.	
1. Stem scarcely 15 cm. high. Leaves 2·5–4 cm. long	5. *A. pygmæa.*
2. Stem exceeding 15 cm.	
a. Stem reaching 45 cm. Leaves 2·5–10 cm. long; they and the sheaths clothed with long soft hairs ...	6. *A. ciliata.*
b. Stem reaching 90 cm. Leaves 10–15 cm. long; they and the sheaths glabrous or nearly so	7. *A. Metzii.*
c. Stem reaching 4 ft. Leaves 20–30 cm. long, sparsely hairy; sheaths glabrous or nearly so	8. *A. Lawii.*
III. Spikelets 4–6 mm. long	
1. Panicle branched	
a. Rootstock hard, creeping, not tuberous. Rhachis of panicle angular, glabrous	9. *A. hispida.*
b. Rootstock tuberous. Rhachis of panicle filiform, scaberulous	10. *A. capillaris.*
2. Panicle spicate	
a. Leaves 2·5–4 cm. long	11. *A. spicata.*
b. Leaves 10–20–30 cm. long	12. *A. villosa.*
C. Upper floral glume without awn	13. *A. gigantea.*

1. **Arundinella avenacea,** Munro ex Thw. Enum. Pl. Ceyl. (1864), 362; Hook. f. in F. B. I. vii, 69; Cke. ii, 1000 (*arenacea per err.*).—*A. Campbelliana*, Lisb. in Journ. Bomb. Nat. Hist. Soc. v (1891), 346.—*A. malabarica*, Heyne ex Hook. f. in F. B. I. vii (1897), 69.—*Aira*, no. 3, Griff. Notul. iii, 55, Ic. Pl. Asiat. t. 146. f. iii.

Description: Cke. ii, 1000.—This grass in its young state resembles *A. spicata* so much, that it can easily be mistaken for that species.

Locality: Konkan: Ratnagiri (Woodrow).—*Deccan:* Mahableshwar, very common, 4,500 ft., rainfall 270 inches (Sedgwick & Bell 4510!, Lisboa); Panchgani (Blatter 5383!), Tiger's Path (Blatter & Hallberg B1255!); Khandala, very common (McCann 9604!); Tiger Leap near Lonavala (Woodrow).—*S. M. Country:* Ram Ghat (Ritchie 890).—*Kanara:* Castle Rock (McCann 9854!, Woodrow, Bhide!); Anmod, 1,800 ft., rainfall 200 inches (Sedgwick 3253!); Tinai Ghat, 1,869 ft., rainfall 250 inches (Sedgwick 3269!); Yellapore (Talbot 1035!); Supa (Talbot 2487!); Kumberwada (Talbot 2255!); Karwar (Talbot 1302!); Katgal (Hallberg & McCann A165!); Devimane (McCann 9936!).

Distribution: Khasia, Burma, W Peninsula, Ceylon.

2. **Arundinella tuberculata,** Munro ex Lisboa in Journ. Bomb. Nat. Hist. Soc. v (1891), 344; Hook. f. in F. B. I. vii, 69; Cke. ii, 1000: Janowski in Bot. Archiv i (1922), 24.

Description: Cke. l.c.

Locality: Konkan: Vasco da Gama (Bhide!).—*Deccan:* Panchgani, slopes below Third Tableland (Blatter & Hallberg 1232!); Pasarni Ghat (Blatter & Hallberg 1306!); Poona (Woodrow).—*S. M. Country:* Dry hills between Yelvigi and Savanur, 1,900 ft., rainfall 25–30 inches (Sedgwick 1959!).—

Kanara : Manoli (Talbot 3979 !) ; Jog to Siddhapur, open grass land, rocky soil (McCann 9856 !) ; Katgal, open grass land (Hallberg & McCann A164 !) ; Karwar, open grass land (Hallberg & McCann A163 !).
Distribution : Central India.

3. **Arundinella setosa**, Trin. Gram. Panic. (1826), 63 ; Hook. f. in F. B. I. vii, 70 ; Cke. ii. 1001 ; Duthie Grass. N. W. Ind. 13 ; Janowski in Bot. Archiv i (1922), 24.—*A. hirsuta*, Nees ex Steud. Syn. Gram. 115 ; Hohen. Pl. Ind. Or. no. 920.—*A. stricta*, Nees in Hook. Kew Journ. ii (1850), 102 ; Dalz. & Gibs. 292.
Description : Cke. l.c.
Locality : Konkan : Near Bombay (Ritchie).—*Kanara :* Dandeli (Talbot 2266 !) ; Gersoppa Falls, on rocks in river bed (McCann A166 !, A162 !).
Distribution : W. Himalaya, Khasia Hills, Bihar, Central India, Nilgiris, Ceylon, Tonkin, China, Philippines.

4. **Arundinella tenella**, Nees & Wight ex Steud. Nom. ed. 2, pt. 1 (1840). 143 ; Dalz. & Gibs. 292 ; Duthie Grass. N. W. Ind. 13 ; Lisb. in Journ. Bomb. Nat. Hist. Soc. v (1891), 345 ; Hook. f. in F. B. I. vii, 71 ; Cke. ii, 1001.—*Anemagrostis tenella*, Wight ex Steud. Syn. Pl. Glum. i (1854), 115.—*Arundinella pumila*, Steud. l.c.—*Acratherum pumilum*, Hochst. ex A. Rich. Tent. Fl. Abyss. ii (1851), 414, t. 100.
Description : Cke. ii, 1001.
Locality : Khandesh : Toranmal (McCann 9594 !).—*Konkan :* Pen (McCann 5502 !) ; Bombay (Lambert).—*Deccan :* Mahableshwar, 4,500 ft., rainfall 200 inches (Sedgwick & Bell 4522 !) ; common under the shade of trees (Dalzell, Cooke, Woodrow, Lisboa) ; Panchgani (Blatter 3798 !), Maratha Well (Blatter & Hallberg B1222 !) ; Karli and Khandala (Jacquemont 631) ; Khandala, very common (McCann 5354 !) ; Lonavla (Gammie !, Woodrow) ; Purandhar (McCann 5013 !) ; Igatpuri (McCann 5354).—*Kanara :* Yellapore, 2,000 ft., rainfall 100 inches (Sedgwick 3125 !) ; Haiyal (Talbot 2553 !) ; Dandeli (Talbot 2268 !) ; Tinai (Talbot 2576 !).—A very ornamental grass, found commonly throughout the hilly parts of the Presidency.
Distribution : W. Himalaya, Khasia Hills, Bihar, Central India, W. Peninsula, Abyssinia.

5. **Arundinella pygmaea**, Hook. f. in F.B.I. vii (1896), 72 ; Cke. ii, 1002 ; Janowski in Bot. Archiv i (1922), 25.
Description : Cke. l.c.
Locality : Konkan : Crest of W. Ghats (Woodrow).—*Deccan :* In public garden, Mahableshwar, 4,500 ft., rainfall 270 inches (Sedgwick & Bell 4619 !) ; Khandala (McCann 5318 !) ; Igatpuri (Blatter & Hallberg 5143 !).—*Kanara :* N. Kanara (Lisboa).
Distribution : Endemic.

6. **Arundinella ciliata**, Nees ex Miq. in Verh. Nederl. Ind. iii, iv (1851), 30 ; Janowski in Bot. Archiv i (1922), 25.—*Holcus ciliatus*, Roxb. Fl. Ind. i (1820), 318.—*Arundinella agrostoides*. Trin. Ic. xxiii (1828-36) t 265 ; Cke. ii, 1002.—*A. agrostoides* var. *ciliata*, Hook. f. in F.B.I. vii, 71.—*Brandtia holcoides*, Kunth. Rev. Gram. ii (1835), 127, t. 170.—*Perotis polystachya* Heyne ex Hook. f. l.c. 71.
Description : Cke. ii, 1002.
Locality : Konkan : (Wight).—We have not seen any specimens.
Distribution : India, Philippines.

7. **Arundinella Metzii**, Hochst. in Miq. Anal. Bot. Ind. pt. 2 (1851), 19 ; Steud. Syn. Gram. 116, *excl. syn.* Roxb. ; Cke. ii, 1003.—*Agrostis fusca*, Heyne ex Hook. f. in F.B.I. vii, 72.—*Arundinella agrostoides*, Trin. var. *tenella*, Herb. Ind. Or. Hook. f. & Th. ex Hook. f. l.c.
Description : Cke. ii, 1003.
Locality : *Deccan :* Lonavla (Woodrow).—*S. M. Country :* Devarayi, 1,800 ft., rainfall 90 inches (Sedgwick & Bell 4474 !).—*Kanara :* Yellapore, 2,000 ft., rainfall 100 inches (Sedgwick 3469 !) ; Sunksal, rocky bank of a stream in evergreen forest 500 ft., rainfall 150 inches (Sedgwick & Bell 5040 !) ; Birchy (Talbot 2105 !, 2116 !, 2488 !) ; Dandeli (Talbot 2268 !).

Distribution : W. Peninsula.

8. **Arundinella Lawii,** Hook. f. in Trim. Fl. Ceyl. v (1900), 180 ; Cke. ii, 1003.—*A. agrostoides*, Hook. f. in F.B.I. vii (1896), 71, *partim*.
Description : Cke. l.c.
Locality : Konkan : (Woodrow 35 !) ; N. & S. Konkan (Law).
Distribution : W. Peninsula, Ceylon.

9. **Arundinella hispida,** O. Ktze Rev. Gen. (1891), 761 ; Janowski in Bot. Archiv i (1922), 26.—*Andropogon hispidus*, Willd. Sp. Pl. iv (1805), 908.—*Ischæmum hispidum*, H.B.K. Nov. Gen. et Sp. i (1815), 194.—*Arundinella brasiliensis*, Raddi Agrost. Brasil. (1823), 37, t. 1, fig. 3 ; Trin. Diss. ii, 62, Sp. Gram. Ic. t. 266 ; Hook. f. in F.B.I. vii, 73 ; Cke. ii, 1003.—*A. pallida*, Nees Agrost. Brasil. (1829), 465.—*Acratherium miliaceum*, Link Hort. Berol. ii (1841), 234.—*Orthopogon agrostoides*, Trev. ex Steud. Nom. ed. 2, ii (1841), 234.—*Andropogon virens*, Spreng. Syst. i (1825), 287.—*Arundinella Mikani*, Nees l.c. 465.—*Goldbachia Mikani*, Trin. in Spreng. Neue Entdeck. ii (1821), 81.—*Riedelia Mikani*, Trin. ex Kunth Enum. Pl. i (1833), 515.—*Aira brasiliensis*, Spreng. Syst. i (1825), 278,—*Ischæmum pallidum*, Kunth. Enum. Pl. i (1833), 515.—*Arundinella Ritchiei*, Munro ex Lisboa in Journ. Bomb. Nat. Hist. Soc. v (1891), 343.—*Holcus nervosus*, Roxb. Fl. Ind. i (1820), 318.—*Arundinella nepalensis*, Trin. Sp. Gram. (1828), t. 268 ; Duthie Grass. N. W. Ind. 13 ; Lisboa l.c. 343.
Description : Cke. ii, 1003.—A most variable plant. See Hook. f. in F.B.I. vii, 74.
Locality : Deccan : Mahableshwar, 4,500 ft., rainfall 270 inches (Dalzell & Gibson, Lisboa), in a stream (Sedgwick & Bell 4543 !) ; Panchgani (Woodrow) ; Khandala (Saxton 1205 !, Lisboa) ; Lonavla (Hallberg 9660 !, Garade !, Lisboa).—*Kanara :* Castle Rock, on banks of Duoki River, 1,900 ft. (McCann 4855 !) ; Kalanudi to Supa, 1,800 ft., rainfall 100 inches (Sedgwick & Bell 4872 !) ; Yellapore, in a gravelly stream bed, 2,000 ft., rainfall 100 inches (Sedgwick 3126 !) ; Sumpkhund, in river bed (Hallberg & McCann A159 !) ; Dandeli (Talbot 2241 !).
Distribution : Throughout the hilly parts of India, China, Malaya, Australia, tropical America.

10. **Arundinella capillaris,** Hook. f. in F.B.I. vii (1896), 74 ; Cke. ii, 1004.—*A. mutica*, Nees ex Steud. Syn. Gram. (1855), 116.—*Andropogon capillaris*, Herb. Heyne ex Hook. f. in F.B.I. l.c. 75.
Description : Cke. l.c.
Locality : Konkan : Parel, Bombay Island (Woodrow).—*N. Kanara :* Kalanudi (Woodrow).
We doubt the occurrence of this species in the Bombay Presidency. Woodrow gives two localities, but neither Cooke nor we have seen his specimens. Lisboa (Journ. Bom. Nat. Hist. Soc. v (1891), 8) calls this plant common all over Bombay. If it is really common it is strange that we should never have met it.
Distribution : W. Peninsula.

11. **Arundinella spicata,** Dalz. in Dalz. & Gibs. Bomb. Fl. (1861), 293 ; Hook. f. in F.B.I. vii (1896), 77, *sub speciebus indeterminab.* ; Cke. ii, 1004.
Description : Cke. l.c.
Locality : Deccan : Mahableshwar, common in open localities, 4,500 ft., rainfall 270 inches (Sedgwick & Bell 4508 !), common on the Mahableshwar Hills (Dalzell & Gibson, Woodrow, Cooke) ; Panchgani, very common on the Tablelands (Blatter 3797 !, McCann !).
Distribution : W. Peninsula ; so far endemic.

12. **Arundinella villosa,** Wight & Arn. ex Steud. Syn. Pl. Glum. i (1854), 115 ; Hook. f. in F.B.I. vii, 72 *cum omnibus varietatibus*.—*A. Hookeri*, Munro ex Hook. f. l.c. 73.
Description : Stem 30-40 cm. high, tufted, slender, stiff, leafy at the villous base, villous below the panicles. Leaves 10-20 cm. by 2-2·5 mm., strict, rather rigid, glabrous, tomentose or villous. Ligules of long hairs. Panicle very narrow, 5-10 cm. long, spiciform, rhachis villous ; branches 12-18 mm. long,

brown. Spikelets subdistichously crowded, spreading or erect, 5–6 mm. long, setosely hirsute. Lower involucral glume ⅘ of upper, long-pointed, 3–5-nerved, upper involucral glume subaristately long-pointed, 5-nerved. Lower floral glume sharp-pointed, 5-nerved, neuter or male; upper oblong-lanceolate, very minutely scaberulous, rounded at the tip, sometimes 2-dentate, awn not twice as long as the spikelet, column of awn included, twisted.

The leaves vary a good deal as to their size. In addition to the measurements given above, the following have been observed: 30 cm. by 8 mm. and 5–15 cm. by 6–8 mm.

Locality: Deccan: Khandala (McCann 9602A!, 9002B!).

Distribution: E. Himalaya, Khasia Hills, Central India, Deccan Peninsula, Ceylon.

13. **Arundinella gigantea,** Dalz. in Dalz. & Gibs. Bomb. Fl. (1861), 293; Hook. f. in F.B.I. vii (1896), 76; Cke. ii, 1005.

Description: Cke. l.c.

Locality: Konkan: (Stocks); Kineshvar below the Ghats (Dalzell and Gibson).—*S. M. Country:* Londa (Bhide!); Devarayi (Sedgwick 4474!).—*Kanara:* Castle Rock, in shade (McCann 9853!, Gammie 15668!); Dudsagar Falls (McCann A174!); Nagergali, forests, 1,800 ft., rainfall 80 inches (Sedgwick 2921!); Birchy (Talbot 2250!); Dandeli (Talbot 2593!); Tinai Ghat (Talbot 2626!); Jugglepet (Talbot 1387!); Supa (Talbot 2493!); Karwar (Hallberg and McCann A161!); Gersoppa Falls, on rocks in river bed (Hallberg and McCann A160!); Yellapore (Sedgwick 3469!, Talbot!).

Distribution: W. Peninsula; so far endemic.

63. TRISTACHYA, Nees.

1. **Tristachya barbata,** Nees ex Steud. Syn. Pl. Gram. (1856), 238; Boiss. Fl. Or. v (1881), 552; Duthie Grass. N. W. Ind. 32; Hook. f. in F.B.I. vii, 272; Cke. ii, 1005.—*T. Stocksii*, Boiss. l.c.; Munro in Aitchis. Cat. Panjab Pl. 168; Duthie Fodd. Grass. N. Ind. 51.—*Laudetia barbata*, A. Braun in Flora xxiv (1841) ii, 714.—*Sorghum barbatum*, Hochst. & Steud. Pl. Arab. Exsic. No. 788 ex Hook. f. l.c.

Description: Cke. l.c.

Locality: Sind: (Stocks 1217, 648 ex Cooke).

Distribution: Arabia, Nubia.

64. THYSANOLAENA, Nees in Edinb. N. Philos. Journ. xviii (1835), 180.

Cooke has one species: *Thysanolæna Agrostis*, Nees. We change it into *T. procera*, Mez.

1. *Thysanolæna procera*, Mez. in Janowski. Bot. Archiv i (1922), 27.—*Agrostis procera*. Retz. Obs. iv (1779), 19.—*Melica latifolia*, Roxb. Hort. Beng. (1814), 8.—*Agrostis latifolia*, Heyne ex Hook. f. in F.B.I. vii, 61.—*Agrostis maxima*, Roxb. Fl. Ind. i (1820), 319.—*Thysanolæna maxima*, O Ktze. Rev. Gen. ii (1891), 794.—*Panicum acariferum*, Trin. Sp. Gram. Ic. i (1828), 87.—*Thysanolæna acarifera*, Nees and Arn. in Nov. Act. Leopold. xix, Suppl. i (1843), 181; Lisboa in Journ. Bomb. Nat. Hist. Soc. v (1890), 347; Duthie Grass. N. W. Ind. 13, Fodd. Grass. N. Ind. 21.—*T. Agrostis*, Nees in Edinb. N. Phil. Journ. xviii (1835), 180; Hook. f. in F.B.I. vii, 61; Cke. ii, 1006.—*Myriachaeta arundinacea*, Zoll. & Mor. Syst. Verz. Zoll. (1845–46), 101.—*M. glauca*, Mor. ex Steud. Syn. Pl. Glum. i (1854), 404.

Description: Cke. ii, 1006.

Locality: Gujarat: In bed of nalla (Sedgwick and Bell 5393!); Bansda, Surat District (Woodrow).—*Khandesh:* (Lisboa); Chanseli to Dadgaum, in a dry nalla (McCann 9589!); Dangs (Woodrow).—*Konkan:* Victoria Gardens, Bombay (McCann 9846!); Thana (Lisboa).—*Deccan:* Ganeshkhind Botanic Gardens (McCann 9847!); Nasik (Lisboa).

Distribution: Throughout India, Penang, eastwards to New Guinea.

65. *AVENA, Linn. Sp. Pl. (1753), 79; Gen. Pl. Ed. 5 (1754), 34.

Annual or perennial herbs, low or moderately tall. Panicles narrow or open, usually rather few-flowered of usually large spikelets. Spikelets 2–several-

flowered; rhachilla bearded, disarticulating above the involucral glumes and between the flowering glumes. Involucral glumes about equal, membranous or papery, several-nerved, longer than the lower floret, usually exceeding the upper floret. Floral glumes indurate, except toward the summit, 5–9-nerved, bidentate at the apex, bearing a dorsal bent and twisted awn, which is straight and reduced in *Avena sativa*.

The genus as just described does not include *Trisetum*, Pers. as is the case in Hook. f.'s *Avena* in F.B.I. vii, 274.

Species about 55. Chiefly temperate regions. One species cultivated in the Presidency.

*1. **Avena sativa**, Linn. Sp. Pl. (1753), 79.—The Common Oat.

An annual grass. Stems erect, tufted, smooth, 1·2 m. high. Blades flat, up to 30 cm. high and 12 mm. wide, scabrous, especially on the margins; ligule membranaceous, truncate, 1-3 mm. long, toothed or serrate, decurrent along the margin of the sheath; sheaths smooth, striate, the lower rather papery. Panicle open or more or less contracted, erect or nodding, sometimes 1-sided, the pedicels thickened at the apex. Spikelets large, drooping, variable in size, but usually about 20–25 mm. long; involucral glumes strongly several-nerved, membranaceous, acuminate, scabrous, containing usually 2 florets; floral glumes smooth or slightly hairy at the base, teeth acute but not awned, the dorsal awn absent or, if present, usually straight and not much longer than the involucral glumes, often present only on the lower floret, pale enclosed by the inrolled margin of the glume, densely short-ciliate on the 2 keels.—The florets do not easily disarticulate, which condition is probably due to cultivation.

Locality: Very little cultivated in the Presidency. Has been grown at Hyderabad (Sind), also at military grass farms for military horses at Ahmednagar and elsewhere.

Grows best in the cold weather and always under irrigation.

For a useful introduction to the study of oats see: Herbert Hunter. Oats, their varieties and characteristics. London, 1924.

66. Coelachne, R. Br. Prodr. (1810), 187.

A small, leafy, variable marsh grass. Leaves short, flat or convolute. Spikelets 2-flowered (both flowers perfect or upper imperfect) in open or contracted or spiciform panicles, not articulate on the pedicels, not awned. Rhachilla jointed at the base, produced between the lower and upper floral glume but not beyond the upper. Lower involucral glume suborbicular, concave, obtuse and delicately nerved; upper smaller, more oblong, both persistent. Lower floral glume much longer, subsessile, coriaceous, glabrous, except the shortly bearded callus, pale as long, coriaceous; upper much smaller and pale more or less hairy. Stamens 3; anthers long, narrow. Ovary ovoid; stigmas free. Grain free within the glume and pale.

Tropical Asia, Australia, Madagascar.

1. **Cœlachne pulchella**, R. Br. Prodr. (1810), 187; Hook. f. in F.B.I. vii, 270.

Description: Stems 15–45 cm. high, flaccid, decumbent or ascending, slender or rather stout, leafy up to the panicle. Leaves uniform throughout the stem, 1–2·5 cm. long, lanceolate, subulate, acuminate, distant or subequitantly sheathing, ecostate, minutely scaberulous above, nerves striate; ligule a few hairs. Panicle very various. Spikelets 1–2·5 mm. long, sessile or pedicelled, globose or ovoid. Lower involucral glumes suborbicular or hemispheric, many-nerved, membranous or herbaceous. Lower floral glume hermaphrodite, coriaceous, dorsally rounded, nerves 0 or very obscure, pale, coriaceous; margins incurved; upper much the smallest, often imperfect, neuter or female.

Locality: Deccan: Mahableshwar, by the lake, 4,500 ft., rainfall 270 inches (Sedgwick & Bell 4851 !).—*S. M. Country:* Roadside near Khanapur, 2,500 ft., rainfall 60 inches (Sedgwick 2960 !).—*Kanara:* Kumbmoada (Talbot 2273 !); Karwar, in wet fields (McCann !); Sirsi to Siddhapur, in fields (Hallberg & McCann A47 !); Castle Rock, in a marsh (Bhide !, McCann !).

Distribution: Of the genus.

67. Danthonia, Lam. & DC. Fl. Franc. 3 (1805), 32 ; Hitchcock Genera of Grass. of Unit. St. in Bull. 772 Unit. St. Dept. Agric. (1920), 118.

Annual or perennial grasses, tufted, low or moderately tall. Panicle few-flowered, open or spike-like of rather large spikelets. Spikelets 3-many-flowered, with the uppermost florets reduced, erect, not jointed on their pedicels. Rhachilla hairy, readily disarticulating above the involucral glumes and between the flowering glumes, produced beyond the uppermost glume. Lower involucral glumes empty, subequal, as long as the whole spikelet, persistent, keeled, acute or acuminate, 3-9-(rarely 1-) nerved. Flowering glumes dorsally rounded. ciliate, 7-9-nerved, 2-fid, lobes acute, usually extending into slender awns, a stout awn arising in the sinus ; awn flat, tightly twisted below, geniculate, exserted, including 3 nerves of the glume ; pale broad. Lodicules 2, fleshy. Stamens 3. Styles free. Grain free within the membranous or hardened glume and pale.

Species about 100.—In the temperate regions of both hemispheres, especially abundant in S. Africa.

1. **Danthonia Gammiei,** Bhide in Journ. & Proc. As. Soc. Beng. new series, vii (1911), 513.

Description : Stem 10-60 cm. high, nodes glabrous. Leaves linear, glabrous below, sparsely long-ciliate above, 2·5-7·5 cm. by 2·5-3 mm., base rounded ; ligule a very narrow, truncate, fimbriate membrane ; sheaths glabrous ; upper leaves very much reduced in size. Peduncle and rhachis hairy ; panicle lax, racemose, 2·5-5 cm. by 12-16 mm. Spikelets few, short-pedicelled, about 18 mm. long excluding the awns. Involucral glumes empty, lanceolate, acuminate, lower one strongly 5-nerved, dorsally rounded, glabrous, subscoriaceous, margins membranous ; upper one by $\frac{1}{3}$ shorter than the lower, membranous, 3-nerved. Lower floral glume without the awns much smaller than the involucral glumes, terete, convolute, 7-9-nerved, dorsally villous all over, 2-dentate with a stout broad median awn ; column of awn golden yellow, twisted and shining, tail minutely scabrid, dorsally narrowly 2-channelled ; teeth produced into small slender awns reaching as far as the column of the median awn, with a fringe of long white hairs at the junction of the lateral awns with the glume ; rhachilla produced and terminating in a minute, ciliate, awned or awnless barren glume (upper floral glume) ; lodicules membranous, half as long as the anthers, oblong, emarginate. Stamens 3. Styles 2, distinct. Anthers and plumose stigmas protruding from the top of flowering glume.

Locality : Kanara : Castle Rock (Gammie !) ; Jog to Siddhapur, open grass land on rocky soil (McCann A50 !, A51 !) ; Mirjan, laterite flats (Hallberg A49 !).

Distribution : So far endemic.

68. Phragmites, Adans. Fam. Pl. ii (1763), 34, 559 ; Cke. ii, 1006 (*Phragmites*, Trin.).

Some European authors have taken up *Tirichoon*, Roth. Archiv. Bot. Roemer i, pt. 3 (1798), 37 as antedating *Phragmites*, Trin. Fund. Agrost. (1820), 134. The latter name, however, dates from Adanson (1763) and should be retained. Cf. M. L. Fernald. The Generic name Phragmites in Rhodora 24 (1922), 55-56. Also : Hitchcock. Genera of Grass. Unit. St. in Bull. 772 Unit. St. Dept. Agric. (1920), 64.

Species 3. One in tropical Asia, one in S. America and one cosmopolitan.

1. **Phragmites Karka,** Trin. ex Steud. Nom. ed. 2, pt. ii (1841), 324 ; Cke. ii, 1007.—For synonyms see Hook. f. vii, 304.

Description : Cke. l.c.

Locality: Sind: Keti (Blatter & McCann D652 !, D653 !) ; Tatta, Kullan Kote Lake (Blatter & McCann D654 !). *Gujarat:* Mahals-Dangs, by a stream, 800 ft., rainfall 100 inches (Sedgwick & Bell 5390 !) ; Anjar, Cutch (Blatter 3740 !).—*Khandesh:* Bhusawal, N. E. Tapti River (Blatter & Hallberg 4436 !) ; Chanseli Hill, N. slope, watercourse (McCann A44 !, A45 !) —*Deccan :* Dhond (Woodrow).—*S. M. Country :* Banks of Warda River, Bangalore Road, 1,800 ft., rainfall 33 inches (Sedgwick 2092 !); Haveri (Talbot 2178 !, 2198 !).—*Kanara:* Supa, 2,100 ft. (Talbot 2195 !).

Distribution : More or less throughout India, tropical Asia, Afghanistan, Japan, Australia, Africa.

*69. ARUNDO, Linn. Sp. Pl. (1753), 81 ; Gen. Pl. ed. 5 (1754), 35.

Tall, stout, perennial grasses with broad linear blades and large plume-like terminal panicles. Spikelets 2–7-flowered, laterally compressed, in large decompound panicles ; flowers mostly bisexual ; rhachilla disarticulating above the involucral glumes and between the flowering glumes, joints short, glabrous. Involucral glumes equal, broadly lanceolate, shortly acuminate, keeled, membranous, 3–5-nerved. Floral glumes more or less equalling the involucral glumes, ovate to lanceolate-ovate, acuminate, finely bifid or entire, long-hairy below, 5–9-nerved, 3 nerves more or less percurrent or excurrent, the rest short, the middle nerve often produced into a short, fine bristle ; callus short, shortly bearded. Pales slightly exceeding ½ the length of the floral glume, 2-keeled. Lodicules 2, obovate, nerved, glabrous. Stamens 3. Ovary glabrous ; styles distinct, almost as long as the laterally exserted plumose stigmas. Grain obovoid-oblong, broad, loosely enclosed in the floral glume and pale ; hilum basal, punctiform ; embryo occupying almost wholly one side of the grain.

*1. **Arundo Donax,** Linn. Sp. Pl. (1753), 81.—For synonyms see Hook. f. in F. B. I. vii, 303.

Description : Stem creeping below, erect, 1–3 m. high, smooth, hollow, very many-noded, simple or scantily branched, internodes slightly exceeded by the sheaths, these very tight, firm, smooth. Blades linear-lanceolate from a broad base, long-tapering to a very fine point, more or less drooping, 30–60 cm. long, 2–5 cm. broad, smooth. Panicles erect, 30–60 cm. long ; branches scaberulous, erect or drooping ; spikelets 8–10 mm. long, light brown. Involucral glumes glabrous ; floral ones 6–10 mm. long ; hairs 5–6 mm. long. Anthers 3 mm. long. Grain 2·5 mm. by almost 1 mm.

Locality: Often grown in gardens.

Distribution : Lower Himalaya, Punjab, Naga, Nilgiri and Coorg Hills, N. Asia, N. Africa, Europe.

70. POLYPOGON, Desf. Fl. Atlant. i (1798), 66 ; Hook. f. in F.B.I. vii, 245

Annual or perennial, usually decumbent grasses, with flat blades. Spikelets 1-flowered, minute, jointed (but persistent) on the pedicels, laterally compressed, keeled, densely crowded on the short branches of a spiciform or lobed panicle ; rhachilla not produced beyond the lower floral glume. Glumes 3. Involucral glumes equal, concave, keeled, bifid, notched or entire, with a slender awn below the tip or in the sinus. Lower floral glume much smaller, hyaline, sessile, truncate, toothed, awned or not ; pale small, 2-nerved. Lodicules 2, falcate. Stamens 1–3 ; anthers small. Ovary glabrous ; styles free. Grain obovoid, free within the glume and pale.

Species about 10.—Temperate regions of the world, chiefly in the Eastern Hemisphere.

1. **Polypogon Monspeliensis,** Desf. Fl. Atlant. i (1798), 66.—For synonyms see Hook. f. in F.B.I. vii, 245.

Description : Stems tufted, 10–60 cm. high, stout or slender, leafy, base geniculate. Leaves 7–15 by 3–6 mm., green, ligule oblong. Panicle 1–15 cm. by 6–10 mm. broad, pale yellowish green, silky, sometimes lobulate from the projecting branches. Spikelets 1–2 mm. long, minutely pubescent, very shortly pedicelled. Involucral glumes very variable in breadth, obovate-oblong, sides scaberulous, keels scabrid, margins ciliate, tip entire, notched or very shortly 2-fid ; awns from the length of the glume to 8 mm. long, excessively delicate. Lower floral glume very small, oblong, glabrous, 2-fid, awned or not ; pale oblong, tip notched. Anthers very minute, short. Ovary ovoid.

Locality : Sind : Sukkur (Bhide !). Shikarpur (Bhide !)

Distribution : Tropical and temperate regions.

71. HELEOCHLOA, Host. Gram. Austr. i (1801), 23 ; Cke. ii, 1011.

Species about 7.—Mediterranean-oriental.

1. Panicles less than 2·5 cm. long ... ... 1. *H. schœnoides.*

2. Panicles reaching 8 cm. ... ... 2. *H. dura.*

1. **Heleochloa schoenoides,** Host. Gram. Austr. i (1801), 23, t. 30 ; Cke. ii, 1011.—For synonyms see Hook. f. in F.B.I. vii, 235.

Description : Cke. l.c.

Locality : Sind: Bhubak (Cooke !).

Distribution : Punjab, W. Himalaya, Kashmir, Bundelkhand, westwards to the Atlantic.

2. **Heleochloa dura,** Boiss. Fl. Or. v (1881), 477 ; Cke. ii, 1011.—For synonyms see Hook. f. in F B.I. vii, 236.

Description : Cke. l.c.

Locality : Sind : Salt-water creeks (Stocks 455) ; Gholam in Indus Delta (Blatter and McCann D688 !).

Distribution : Arabia.

72. GARNOTIA, Brogn. ; Cke. ii, 1012.

1. 5–20 cm. high, growing on trees. Leaves 2·5–5 cm. long ... ... 1. *G. arborum*
2. 30–60 cm. high. Leaves 7–20 cm. long ... 2. *G. stricta.*

1. **Garnotia arborum,** Stapf ex Woodrow in Journ. Bomb. Nat. Hist. Soc., xiii (1901), 439 ; Cke. ii, 1013.

Description : Cke. l.c.

Locality : Igatpuri (McCann 4598 !) ; Lonavla (Gammie 15501 !) ; on trees at Nandgaon on the crest of the Ghats 10 miles S. of Lonavla (Woodrow 30) ; Kalsubai Hill, under a steep rock (Patwardhan 1189 !).

Distribution : Apparently endemic.

2. **Garnotia stricta,** Brogn. in Duperr. Voy. Bot. (1829), 133, t. 21 ; Cke. ii, 1013.

Description : Cke. l. c.

Locality : Konkan : Pen (McCann 5501 !) ; Kalyan (Talbot !) ; between Neral and Karjat (Woodrow).—*Deccan :* Khandala, St. Mary's Villa, on root (McCann A299 !) ; Igatpuri (McCann 4589 !) ; Panchgani (Blatter and Hallberg B1283 ! ; B1305 !).—*Kanara :* Top of Guddhelli (Hallberg & McCann A303 !) ; Gersoppa Falls (Hallberg & McCann A300 !).

Distribution : Himalayas, Khasia Hills, Bighar, W. Peninsula, Sandwich Islands.

73. ARISTIDA, Linn. Sp. Pl. (1753), 82 ; Cke. 1007.

Species about 150. In the warmer regions of the world.

We shall have to refer repeatedly to the splendid monograph by J. Th. Henrard : A Critical Revision of the Genus Aristida in Mededeelingen van s' Rijks Herbarium, Leiden, No. 54 (1926) and No. 54A (1927). So far 2 vols. have appeared.

Cooke describes 7 species. We retain them and add *Aristida mutabilis*, Trin. & Rupr., and *A. pogonoptila,* Boiss.

A. Awns without column
  I. Involucral glumes not awned ... ... 1. *A. Adscensionis.*
  II. Involucral glumes awned
    1. Spikelets 17 mm. long ... ... 2. *A. setacea.*
    2. Spikelets 10 mm. long ... ... 3. *A. Hystrix.*
    3. Spikelets 6 mm. long ... ... 4. *A. mutabilis.*
B. Awns with a column
  I. Column of awn articulate on the floral glume
    1. Awn plumose
      a. Glumes glabrous. Central awn without a naked tip ... . 5. *A. pogonoptila.*
      b. Glumes not glabrous. Central awn with a naked tip ... ... 6. *A. hirtigluma.*
    2. Awn not plumose
      a. Stems less than 15 cm. high. Lower

involucral glume 5 mm. long ... 7. *A. hystricula.*
b. Stems reaching 2 ft. high. Lower involucral glume 22 mm. long ... 8. *A. funiculata.*
II. Column of awn not truly articulate on the floral glume, though readily separating 9. *A. redacta.*

1. **Aristida Adscensionis,** Linn. Sp. Pl. (1753), 82 ; Kunth Enum. Pl. i, 190 ; Steud. Syn. Gram. 139 ; Hook. f. in F. B. I. vii, 294, *excl. synonymis aliquibus* ; Cke. ii, 1008.—*A. abyssinica,* Trin. & Rupr. Sp. Gram. Stip. in Act. Acad. Petrop. ser. vi, v (1842), 134.—*A. canariensis,* Willd. Enum. (1809), 99.—*A. modatica,* Steud. Syn. Pl. Glum. 1855), 139.—*A. curvata,* Nees var. *abyssinica,* Rich. Tent. Fl. Abyss. ii (1851), 392.—*A. divaricata,* Jacq. Eclog. Gram. (1813), 7, t. 6 (*non* Humboldt *et* Bonpl. *nec* Lagarca).—*A. Heymanni,* Regel in Act. Hort. Petrop. vii, 2 (1881), 649.—*A. hystrix,* Duthie Fodd. Grass. N. Ind, 47, t. 31 (*non* Linn. f.).—*A. aethiopica,* Trin. et Rupr. l.c. (1842), 134, *non* 167 *sicut habet* Hook. f.—*A. Adscensionis,* Linn. var. *aethiopica,* Hook. f. in F. B. I. vii, 225.—*A. Ehrenbergii,* Trin. *et* Rupr. l.c. (1842), 136.—*A. Adscensionis,* Linn. var. *Ehrenbergii,* Henrard l.c. i (1926), 158.—*A. festucoides,* Poir. Encyclop. i (1810), 453.—*A. Adscensionis,* Linn. var. *festucoides,* Henrard l.c. i (1926), 177.—*A. Adscensionis,* Linn. var. *angustifolia,* Pilger in Henrard l.c. i (1926), 9.—*A. Adscensionis,* Linn. var. *typica,* Stapf in Hook. f. Fl. Brit. Ind. vii, 224.—*A. Adscensionis,* Linn. var. *bromoides,* Henrard l.c. i (1926), 62.—*A. coarctata,* H. B. K. Nov. Gen. & Sp. i (1815), 122.—*A. debilis.* Mez. in Fedde Rep. sp. nov. xvii (1921), 151.—*A. fasciculata,* Torrey in Ann. Lyc. Nat. Hist. New York i, pt. 1 (1824), 154.—*A. Grisebachiana,* Fournier Mex. Pl. pt. ii, Gram. (1881), 78.—*A. Adscensionis,* Linn. subsp. *guineënsis,* Henrard l.c. i (1926), 216.—*A. Hermanni,* Mez in Fedde Rep. sp. nov. xvii (1921), 153.—*A. Adscensionis,* Linn. var. *humilis,* Henrard l.c. (1927), 247.—*A. interrupta,* Cav. Ic. v. (1799), 45, t. 471, fig. 2.—*A luzoniensis,* Cav. Ic. v (1799), 45, t. 470, fig. 2.—*A. Adscensionis,* Linn. var. *condensata,* Henrard l.c. ii (1927), 318.—*A. macrochloa,* Hochst. in Flora xxxviii (1855), 200.—*A. maritima,* Steud. Syn. Pl. Glum. (1855), 137.—*A. mauritiana,* Hochst. ex A. Rich. Tent. Fl. Abyss. ii (1851), 392.—*A. mongholica,* Trin. & Rupr. l.c. (1842), 133.—*A. nana,* Steud. Syn. Pl. Glum. (1855), 137.—*A. nigrescens,* Presl. Reliq. Haenk. i (1830), 223.—*Chætaria canariensis,* P. Beauv. Agrost. 30.

The above is a list of synonyms which have been included by Henrard under *A. Adscensionis,* Linn. either as representing the typical plant or as subspecies and varieties.

The following is a list of synonyms which Hook. f. in the F.B.I. (vii, 224, 225) had cited under *A. Adscensionis,* but which have to be excluded according to Henrard's recent investigations.

Aristida cærulescens, Desf. Fl. Atl. i (1798), 109, t. 21, f. 2, treated as a distinct species by Henrard i, 99.—*A. chætophylla,* Steud. Syn. Pl. Glum. (1855), 420, no. 108*b*.—*A. depressa,* Retz. Obs. iv (1786), 22 (ex Henrard i, 136). —*A. elatior,* Cav. Ic. vi (1799), 65, t. 581, fig. 1 (*non* Doell), put by Henrard (p. 161) under *A. cærulescens,* Desf.—*A. gigantea,* Linn. f. Suppl. (1781), 113. Henrard (i, 199) is doubtful about the identity of this species, as he has not seen the type.—*A. Jacquiniana,* Tausch in Flora ii (1836), 508, considered by Henrard (ii, 268) as a distinct species.—*A. paniculata,* Forskal in Fl. Aegypt. —Arab. (1775), 25. Hook. f. considers it to be identical with *A. Adscensionis* 'ex descript.' Trinius, however, observes that Forskal's diagnosis agrees with nearly all the Aristidas with naked awns. Before we can find Forskal's type it will be impossible to place his plant with anything like certainty. (See Henrard ii, 418).—*A. mutabilis* var. *æquilonga,* Trin. & Rupr. l.c. (1842), 150. Henrard l.c. ii (1827), 366 retains *A. mutabilis* as a distinct species and considers the specimen mentioned under the variety *æquilonga* as the type-specimen of *A. mutabilis.*—*Chætaria cærulescens,* P. Beauv. Roem & Schult. Syst. ii, 294, identical with *A. cærulescens,* Desf.—*C. depessa,* P. Beauv. Agrost. 30.—*C. elatior,* P. Beauv. Agrost. 30.—*C. gigantea,* P. Beauv. Agrost., doubtful.

Description : Cke. ii, 1008.

Note : Cooke includes under *A. Adscensionis* the plant called *A. depressa,* Retz. Obs. iv (1789), 22 by Dalz. & Gibs. in their Flora of Bombay, and stated by them to occur 'on dry hills'. Neither Cooke nor we have seen the specimen and so we cannot know whether it is the real *Aristida depressa* of Retz. or

whether it belongs to *A. Adscensionis*. If it is Retz.'s species we would have to add *A. depressa*, Retz. to the Bombay Flora, as it is considered to be a species distinct from *A. Adscensionis*.

For the benefit of botanists who wish to clear up this point we quote from Henrard, p. 137, where he points out the difference between the two species. 'Well-developed plants (of *A. depressa*) have sterile innovation-shoots but the root-system is rather faint and much resembles that of annual grasses. The blades are thin and setaceously convolute and the panicles are very loose and open. The spikelets differ from those of *A. Adscensionis* in the very unequal length of the glumes, the lower glume is about ⅔ as long as the upper and both are moreover very acute, the lower distinctly awned, the upper without a bifid apex and slightly pointed.'

Locality : Sind : Laki (Bhide!); Sehwan to Laki, foot of hills (Sabnis B612 !) ; Umerkot, sand dunes (Sabnis B1075 !) ; Tatta (Blatter & McCann D626 !), Kullan Kote Lake (Blatter & McCann D625 !).—*Gujarat :* Ahmedabad (Saxton 1066 !) ; Bhuj Hill, Cutch (Blatter 3769 !) ; road to Lasandra (Chibber !) ; Sevalia (Chibber !) ; road to Gogka (Chibber !) ; Jetalsar, Kathiawar (Woodrow 43).—*Khandesh :* Bor, Tapti River (Blatter & Hallberg 5412 !) ; Toranmal (McCann A230 !).—*Deccan :* Pashan (Gammie !) ; Manmad (Blatter 9973 !) ; Happy Valley, Ahmednagar District (Chibber !) ; Panchgani (Blatter & Hallberg B1315 !) ; Poona (Cooke, Woodrow) ; Bowdhan Hill near Poona (Woodrow 38).—*S. M. Country :* Dharwar, 2,400 ft., rainfall 34 inches (Sedgwick & Bell 4346 !) ; Haveri (Talbot 2181 !) ; Ranibennur (Jouvhkat !) ; Gokak Hills (Bhide !).

Distribution : Most warm countries.

2. **Aristida setacea** Retz. Obs. iv (1786), 22 ; Hook. f. in F.B.I. vii, 225 ; Cke. ii, 1008 ; Haines Bot. Bihar & Orissa 977.

We are not in a position to say how far Hook. f.'s synonymy is correct.

Description : Cke. l.c.

Locality : Gujarat : Rajkot, Kathiawar (Woodrow).—*Khandesh :* Dadgaum (McCann 9764 !).—*Konkan :* Vetora (Sabnis 33677 !) ; Vengurla, sea coast (Chibber !) ; Salsette (Graham).—*Deccan :* Manmad (Blatter 229 !) ; Khandala (Graham) ; Ganeshkhind Botanic Gardens (Patwardhan !).—*S. M. Country :* Kappatgudd Hills, 2,600 ft., rainfall 30 inches (Sedgwick & Bell 5217 !) ; Dharwar, 2,500 ft., rainfall 34 inches (Sedgwick 1822 !) ; dry hills and fields N. of Dharwar (Sedgwick 3778 !) ; Byadgi (Talbot 1759 !) ; Badami (Bhide !).—*Kanara :* Karwar, common (Sedgwick & Bell 5065 !) ; Halyal (Talbot 2161 !).

Distribution : Bihar, W. Peninsula, Mascarene Islands.

3. **Aristida Hystrix**, Linn. f. Suppl. (1781), 113 (*non* Thunbg.) ; Roxb. Fl. Ind. i, 350 ; Graham 335 ; Dalz. & Gibs. 295 ; Hook. f. in F.B.I. vii, 225 ; Cke. ii, 1009.

Description : Cke. l.c.—Hooker f.'s statement (l.c.) that the callus is naked is not correct. Cke. (l.c.), however, is right when saying that it is shortly villous.

Locality : Gujarat : Daman, on sand hills (Bhide !).—*S. M. Country :* Tadas, dry hillsides, 2,000 ft., rainfall 35 inches (Sedgwick 3823 !) ; Dharwar (McCann !, Sedgwick !) ; Haveri (Talbot 2182 !) ; Badami (Bhide !, Cooke, Woodrow).

Distribution : Central Provinces, W. Peninsula.

4. **Aristida mutabilis**, Trin. & Rupr. in Mem. Acad. Petersb. ser. vi (1842), 150 ; Hook. f. in. F.B.I. vii, 226, *excl. aliquib. syn.*—*A. articulata*, Edgew. in Journ. Proc. Linn. Soc. vi (1862), 209 ; Aitchis. Cat. Panjab Pl. 164 ; Duthie Grass. N. W. Ind. 26, Fodd. Grass. N. Ind. 47.—*A. mutabilis*, Trin. & Rupr. var. *tangensis*, Henrard l.c. ii (1927), 368.—*A. longeradiata*, Steud. Syn. Pl Glum. (1855), 140.—*A. hoggariensis*, Batt & Trib. Bull. Soc. Bot. Fr. Tome liii, série iv, Tome vi (1906), Sess. extraor. avril 1906, p. xxxii.—*A. mutabilis*, Trin. & Rupr. var. *hoggariensis*, Henrard l.c. ii (1927), 239

The following synonyms given by Hook. f. l.c. must be excluded : *Aristida Kunthiana*, Trin. & Rupr. in Mem. Acad. Petersb. ser. vi (1842), 151, a distinct species.—*Aristida meccana*, Hochst. *ap.* Trin. & Rupr. l.c. 152, a distinct species.

Description : An annual grass. Stems 15–30 cm. high, many ascending from the root, simple or proliferously branched, slender. Leaves 2·5–7·5 cm. long, very slender, curved, convolute, rigid, smooth. Panicle 7–15 cm. long, very narrow, subcylindric ; branches very short, crowded or sometimes with a few remote lower down on the stem, ascending from a naked base and bearing a dense oblong fascicle of spikelets ; rhachis smooth, branches scaberulous. Spikelets (excl. awns) 6 mm. long, very short-pedicelled, pale green or straw-coloured. Lower involucral glume 5 mm. long, shortly awned, keel scaberulous : upper 6 mm. long, tip 2-toothed below the awn. Floral glume scaberulous, callus shortly bearded, awn obscurely articulate with the glume, column nearly as long as the glume, slender, smooth, branches capillary, rather short, central one about 12 mm. long.

Locality : Sind : Sehwan to Laki, foot of hills (Sabnis B235 !).—*Khandesh :* W. Khandesh (Blatter !).

Distribution : Punjab, Sind, Rajputana, Khandesh, S. India, Arabia, tropical Africa.

5. **Aristida pogonoptila,** Boiss. Fl. Or. v (1884), 496 ; Henrard l.c. ii (1927), 456.—*Arthratherum pogonoptilum,* Jaub. and Spach Ill. Pl. Or. iv (1850–53), 56, t. 337.

Description : A perennial grass. Rhizome short, oblique, branching. Stems 15–45 cm. high, strict or geniculate, erect, simple or sparsely branching, slender, terete, glabrous, smooth, obsoletely and finely striate, few-noded, leafy at the base and covered with imbricate sheaths. Uppermost internode at flowering time scarcely longer than the sheath ; lower internodes longer than the sheaths. Nodes quite glabrous, mostly rufescent. Leaves glaucescent, thin, more or less flexuose or rarely rigid, keelless, on the back finely papillose, articulate on the sheath. Lower leaves 7–25 cm. long, the uppermost very often short (2·5–5 cm.). Lowest sheaths aphyllous, chartaceous, straw-coloured, persistent, subcomplicate, striate, ovate or oblong-lanceolate, mostly acuminate. Proliferous sheaths rotund-truncate, keelless, nerved, densely ciliate with long, white hairs at the apex, densely bearded at the mouth with a ring of short bristles, otherwise glabrous, the upper ones herbaceous, tubular-involute. No ligule. Panicle 7·5–15 cm. long, oblong, somewhat lax, simple and made up of many spikelets. Rhachis filiform, continuous, semiterete, scabrous, strict. Branchlets capillary, flexuose, scabrous, alternate, distichous ; the spikelets arranged in racemes, pedicelled, mostly 3–5, unequal, getting shorter upwards ; pedicels capillary, scabrous, thickened at the apex, most of them longer than the glume. Glumes 3. Involucral glumes awnless, of unequal length, subnavicular, 3-nerved, glabrous or with scattered hairs on the back and the margins. Lower one shorter, usually fimbriolate at the apex ; upper one inserted slightly higher up, narrower than the lower one and about 2 mm. longer, slightly narrowed at the base, emarginate at the apex. Floral glume (including the stalk and awn) about 5 cm. long. Stalk stout, turbinate, densely setulose, bearded-hirsute at the apex. Inner pale tubular-involute, thinly 3-nerved, chartaceous, keelless, oblong, glabrous, cinereous or black-violet, long awned, on the back papillose-scabrous, especially from the middle to the apex, obtusely emarginate after the awn has fallen. Awn deciduous, setaceous-subulate, far below the middle geniculate and trifurcate ; the undivided part almost as long as the glume, contorted, erect, canaliculate, filiform, papillose-scabrous, near the apex conspicuously bearded-hirsute, otherwise naked, or laxly hairy ; lateral awns capillary, naked, scabrous, more or less diverging, strict, about ⅓ the length of the central one and much thinner ; central awn strict, long-plumose, at the base setaceous-filiform, upwards capillary. Inner pale minute, membranous, hyaline, nerveless, involute, keelless, glabrous, cuneate-obovate, truncate or rotundate at the apex, obsoletely crenulate. Lodicules 2, submembranous, glabrous, finely striate, obliquely ovate, obtuse. Stamens 3. Filaments capillary. Anthers yellowish, glabrous, linear, elongate, emarginate at apex and base. Ovary obovate ; quite glabrous. Styles 2, terminal, elongate, filiform, densely plumose, laterally exserted.

Hook. f. in F.B.I. vii, 228 included this species under *A. hirtigluma*, Steud. but, according to Henrard, it ' differs in the glabrous glumes, in the shorter column, more hairy and barbulate at the point of insertion of the 3 awns and in the more loosely and longer plumose central awn, without a naked tip.'

Locality : Sind (ex Boiss.).
Distribution : Punjab, Sind, Baluchistan.

6. **Aristida hirtigluma,** Steud. Nom. ed. 2, pt. 1 (1840), 131, *et* Syn. Gram. (1855), 144 ; Trin. & Rupr. in Mem. Acad. Petersb. (1842), 171 ; Aitchis. Cat. Panjab. Pl. 164 ; Duthie Grass. N. W. Ind. 26 ; Fodd. Grass. N. Ind. 47 ; Boiss. Fl. Or. v, 496 ; Hook. f. in F. B. I. vii, 227, *excl. aliquibus syn.* ; Cke. ii, 1009.—*A. ciliata,* Steud. Hochst, herb. arab. un. it. no. 165 (*non* Desf.) ex Henrard.—*A. ciliata,* Steud. & Hochst. ex Steud. Nom. ed. 2, pt. 1 (1840), 131 (*non* Desf.).—*A. Schimperi,* Hochst. & Steud. ex Steud. l.c. 143.—*Arthratherum ciliatum,* Nees Fl. Afr. Austr. i, Gramineae (1841), 182, *excl. syn.*

The following synonyms cited by Hook. f. in F. B. I. vii, 228 have to be excluded :

Aristida decorata, Steud. Syn. Pl. Glum. (1855), 421, which is *A. Raddiana,* Savi.—*Aristida paradisea,* Edgew. in Journ. As. Soc. Beng. xvi, ii (1847), 1219, which is a distinct species. See Blatter Fl. Aden in Rec. Bot. Survey Ind. vii, 3 (1916), 380.—*Aristida pogonoptila,* Boiss. Fl. Or. v. (1884), 496, a distinct species.

Description: Cke. l.c.

Locality : Sind : Bholari (Bhide !) ; Sehwan, sand hills (Bhide !) ; Laki (Bhide !) ; hills near Bullo Khan (Woodrow !) ; Sehwan to Laki, foot of hills (Sabnis B614 !).

Distribution: Tunis, Upper Egypt, Sinai, Syria, Nubia, Abyssinia, Eritrea, Highlands of Somaliland, Arabia, Sind, Punjab.

7. **Aristida hystricula,** Edgew. in Journ. Linn. Soc. vi (1862), 208; Aitchis. Cat. Punjab Pl. 164 ; Duthie Grass. N. W. Ind. 26 ; Fodder Grass. N. Ind. 47 ; Hook. f. F. B. I. vii, 227 ; Cke. ii, 1009.

Description: Cke. l.c.—Henrard l.c. ii (1927), 251, points out that ' the most striking character, a character neglected by all the authors who studied the species, is the densely hairy bifid callus.' Hooker l.c., therefore, when saying that the callus is ' minute, glabrous ' is not correct. Cooke does not describe the callus.—Apparently no Indian species has a naked callus.

Locality: Sind: Laki (Bhide !) ; Bholari (Bhide !) ; Hyderabad (Bhide !) ; Jamadar ka Landa near Karachi (Stocks 1187).

8. **Aristida funiculata,** Trin. & Rupr. in Mem. Acad. Petersb. ser. 6, vii (1849), 159 ; Aitchis. Cat. Panjab Pl. 164 ; Boiss. Fl. Or. v, 492 (*partim*) ; Duthie Fodd. Grass. N. Ind. 47 ; Hook. f. in F. B. I. vii, 226 ; Cke. ii, 1010 —*A. macrathera,* Rich. Tent. Fl. Abyss. ii (1851), 393; Boiss. l.c. 493 (*Macranthera*).—*A. Mallica,* Edgew. in Journ. Proc. Linn. Soc. vi (1862), 206.—*A. funiculata,* Trin.&Rupr. var. *mallica,* Henrard l.c. ii (1927), 328.—*A. paradoxa,* Steud. *ap.* Schmidt Fl. Cap. Verd. (1852), 140.—*A. funiculata,* Trin. & Rupr. var. *paradoxa,* Henrard l.c. ii (1927), 425.

Description: Cke. ii, 1010.

Locality : Sind : Mirpurkhas (Sabnis B1038 !) ; Gharo (Blatter & McCann D622 !) ; Tatta, tombs (Blatter & McCann D623 !) ; Ghulamalla (Blatter & McCann D624 !) ; Jam village (Woodrow 19).—*Gujarat :* Red earth upland N. of Taloda (Sedgwick !) ; dry waste land, Ahmedabad (Sedgwick !) ; Bhuj, Bhodir Maka, Cutch (Blatter 3728 !).—*Khandesh :* Bor, Tapti River (Blatter & Hallberg 4416 !) ; Amalner, Bori River (Blatter & Hallberg 5108 !).—*Deccan :* Poona (Lisboa) ; Dapuri near Poona (Jacquemont 489) ; Pashan near Poona (Gammie !) ; Kirkee to Poona, railway line (Garade 816 !) ; Katraj Ghat (Bhide 1041 !) ; Panchgani (Blatter & Hallberg B1310 !) ; Satara (Lisboa) ; Sholapur (Lisboa) ; Wai (Talbot 4483 !) ; Nasik (Bourke !) ; Bairawadi, Purandhar (McCann 5062 !) ; Rahuri (Nana A227 !).—*S. M. Country:* Dry fields Yelvigi 1,800 ft., rainfall 28 inches, (Sedgwick & Bell 4898 !) ; Belgaum (Woodrow) ; near Belgaum (Woodrow !) ; Badami (Bhide !).

Distribution: Punjab, Rajputana, W. Peninsula, Baluchistan, Arabia, tropical Africa.

9. **Aristida redacta,** Stapf in Kew Bull. (1892), 85 ; Hook. f. in F. B. I. vii, 227 ; Cke. ii, 1010.—*Stipa aristoides,* Stapf ex Lisboa in Journ. Bomb. Nat. Hist. Soc. vii (1893), 358 ; Prain Beng. Pl. 1211.

Description: Cke. l.c.

Locality: Konkan: Trombay, common on the hillside (McCann A212 !, A213 !) ; Kankeshwar hill, Alibag (Bhide !).—*Deccan :* Lonavla (Woodrow) ; Junnar, Poona District (Woodrow) ; Wai (Talbot 4484) ; Lohagad, plain (McCann 9503 !) ; Bairawadi below Purandhar (McCann 5063 !) ; Pashan (Gammie !); Panchgani (Blatter & Hallberg B1275 !)—*S. M. Country:* Hubli, barren hillside, 2,200 ft., rainfall 28 inches (Sedgwick & Bell 4929 !) ; Yelvigi, dry fields, 2,000 ft., rainfall 28 inches (Sedgwick & Bell 4897 !) ; Dharwar, 2,400 ft., rainfall 34 inches (Sedgwick & Bell 4891 ! Talbot 2910) ; Haveri (Talbot 2216 !).—*Kanara* : (Law).— This species commonly grows on open hill sides among other plants by which it is supported as it is very weak and bends over.

Distribution: Central India, Nagpur, W. Bengal, W. Peninsula, S. Persia.

(*To be continued*)

SOME EXTRACTS FROM MY SHIKAR DIARY

Mainly for Novices

BY

Lieut.-Col. R. W. Burton

Indian Army (Retired).

It is in response to the recent appeal of the Editors, that I venture with some diffidence, to put together a few extracts from my shooting diary in the hope that these will be of interest to readers of the Journal, and useful to young sportsmen.

Bullets:

Two valuable lessons were learnt from the following early experience. ' . . . . He fell to a shot in the shoulder from A, got up again and was twice hit in the head and neck. He then went off, very sick, followed up as soon as the beaters were assembled ', this was in our early days, ' plenty of blood; jungle thick and many evergreen bushes. We had tracked for nearly a mile, every moment one of tense expectation, when, dropping into a nullah and peering over the opposite bank, I spotted the tiger lying on his side with his back towards us. He was fifty yards distant. He raised his head, listening no doubt, but must have been far gone. I plugged him in the back, at junction of neck and shoulders, with a conical bullet from my 12-bore Paradox gun followed up by two others in almost the same place. A and C had not seen him, I suppose the slight movement of the tiger's head had caught my eye and not theirs. . . . A fine heavy tiger 9 ft. 1 in. as he lay. The two head shots from A's rifle had not penetrated the skull.'

The 340 grain copper tube bullet of the ·500 black powder express rifle has insufficient base. The use of it has occasioned many accidents and fatalities.

' When A climbed into his tree, all but three of his cartridges fell out of his pocket. He did not know this until firing his third shot.'

Cartridges should never be carried loose in a pocket:

They should be in a cloth pouch, each cartridge separate, the pouch being sewn on inside the coat pocket, or carried on a belt if no coat is worn.

All sportsmen who pursue dangerous game have, sooner or later to follow up a wounded animal. The proper precautions to take have been enumerated by various writers, and by none more

fully and clearly than Dunbar Brander in *Wild Animals in Central India.*

On an occasion subsequent to that described above, the neglect of a very obvious precaution, not, I think, mentioned by any writer on the subject, had a tragic result to which the use of the ·340 bullet mainly contributed.

When starting to follow up a wounded animal make very sure that your weapon is loaded.

'Surely,' the reader will say, 'no one would forget to reload !' Let us see. '. . . The whole business was the result of using the ·340 bullet. Having insufficient base, the bullet, which struck the tigress on the point of the shoulder—a facing shot at 70 yards—had split up and merely made a flesh wound about three inches deep, as I found by probing with my finger and afterwards when skinning.

When the tigress charged, A pulled at the trigger of his rifle without result. It was found that the rifle had not been reloaded. Only the right barrel had been fired in the first instance, and the deep indentation on the cap of the empty case indicated that it had been twice hit by the striker. A died from blood poisoning on the fourth day.

Here is another instance. '. . . . X had fired at the tiger through some undergrowth but the bullet had probably been deflected as we found no blood on the tracks. We followed up, however, to some distance, and came to a very thick ravine. Stones were thrown. There was a false alarm by a bear which came out about 60 yards below us. X took careful aim. There was no report. Our eyes met. He was not loaded, and we were following up a possibly wounded tiger!' So such things do occur, and it is as well to bear the possibility in mind.

Explosive bullets.

A Meade's shell in a 12-bore gun is a most deadly missile but is now seldom used, having been superseded by the several types of bullet specially made for use in shot guns. It has the defect of leading the user of it to coarse and careless shooting ; for an animal hit in the stomach is as completely knocked out as when hit in the chest.

'. . . . I sat on a rock about 60 yards away and in a few minutes the panther emerged to stalk the bleating goat. It fell dead to the shot. The Meade's shell, intended for its heart caught it in the ear ! The skull felt like a bag of nuts. Both eyeballs were blown out of the sockets and hanging on its cheeks.' And again ; '. . . . The tigress fell to the shot, her pace turning her over to face the way she had come.'

The bullet had got her in the side of the head and her eyes were blown out and hanging by threads. This was a Calvert's conical shell from a 12 bore rifle, now an obsolete weapon. A blue bull killed by the same rifle fell over to the shot in the stomach and 'a thin spiral column of smoke could be seen rising out of the wound.' A miss was often registered by the answering report when the shell struck a tree or rock beyond the animal.

When the shot is a close one it is necessary to be very careful to hold low and not shoot over the mark :

'I was seated in a small depression in the ground. The panther could be seen a long way off on the hillside : then again at 100 yards : the next sight of her would be as she topped the slope just in front of me. I was ready ; the top of her head crept into view and then her eyes and nose, not more than five yards away. I got up expecting to see her carcase. It was a clean miss. I had aimed between her eyes and must have gone just over the skull. I should have sighted below, to cut the ground line as it were.' I made the same mistake on one other occasion.

Panthers have but little sense of smell :

. . . . The calf, killed some hundreds of yards from the village, had been dragged into some thin jungle. There was no tree large enough to support a machan. A 'hide' was made in a thick bush. At 6.30 p.m. it was quite light, and I was lying on my back. Heard the panther moving around my shelter which was rather conspicuous owing to the want of cover. Suddenly the loophole was darkened by the panther putting her head into it, her chin over the muzzle of the gun. An involuntary movement of the hand to take hold of the gun-stock caught her eye and she bounded away. In less than five minutes she was back again. . . . ' This panther was so close to me that I could have put my hand through the leaves and caught hold of her leg ; yet she did not detect the presence of a human being. I could cite many similar instances. . . . At last at 8 p.m. (it was June in Central India) he gave up all caution and allowed himself to breathe naturally, which was with the most distressing panting owing to the heat. Making towards the kill, which had been dragged from under the rock where he had placed it, he passed the loophole of the 'hide', constructed of boulders and thorns, at a distance of ten feet and I shot him through the heart with the ·500. Here again the panther failed to detect my presence.

On one occasion, seated in a machan at dusk, I saw a panther pass along a path, within six feet of a tethered village pig without knowing it was there ! The pig was not inodorous ; the evening air was very still ; and the previous evening the panther had refused to kill a buffalo tethered at the same spot. So he should have expected something might be at the place, or, at such a short distance his nose should have informed him. The pig was the colour of a rock and lay like a stone. This fairly recent incident has confirmed my previously formed opinion that panthers at any rate have a very poor sense of smell.

Having mentioned the pig I must add that only on that one occasion have I tied up a village pig. Never again will I do it. His intelligence is great, and his squeals on being taken to the place are heartrending.

The domestic cat has a very good sense of smell. That can be easily tested by putting food of any kind on a mantlepiece where cats are about—this Hotel for instance ; it will surely be scented

out. And I have watched a domestic cat quite obviously use its nose to find where a mouse had gone.

I am inclined to think that tigers have slightly better noses than panthers; not enough to hunt by of course, but sufficient perhaps to enable them to detect me if I sit over a kill in the shelter of a bush. So I will try and get further evidence on the point before putting their noses to the 'acid test' as the Indian politician would express it. I have had, in common with most sportsmen, several instances of tiger passing tethered buffaloes without seeing them.

I have been induced to make these remarks in view of the correspondence on the subject in the *Times* of June 12 and 22. Of the African *Felidæ* it has been stated on high authority that 'Nothing is more certain than that all carnivorous animals hunt almost entirely by scent.' Most sportsmen in India will hold a diametrically opposite view, in respect to tiger and panther at any rate.

'All cats are grey in the dark,' but their senses are not wholly similar. The iris of the tiger's eyes contracts in a circular manner and owing to this he is at a disadvantage, in daylight, as compared with the domestic cat whose iris contracts both vertically and horizontally and so enables it to shut out all light except that admitted by two pin-holes at each end of the slit.

'Is the panther insensitive to a white light?'

That seems to be the case and it is an interesting question. Perhaps members of the Society with the necessary experience will state their views in the matter. No panther on to which I have put an electric light has ever shown any sign of having noticed it, not, even when full in his face at a distance of thirty feet. It is otherwise with tiger. Foxes notice the light, also jackals and hyænas, but they are soon 'tamed'. I must try some experiments on the Hotel cat.

To learn to shoot with a rifle from the left shoulder is not difficult and is a very useful accomplishment.

'. . . . Some monkeys began to swear and scold away to my left front, so I thought the tiger might be coming through the long grass and made ready to shoot in that direction. I was sitting astride a thick bough and could only shoot from the right shoulder to the front and left. Suddenly a movement to the right caught my eye. It was the tiger springing out of the nullah up to the level bank 25 yards to my right. He was making off through the bamboo jungle at a quick walk. I had only just time to throw the rifle over to the left shoulder and take quick aim half right back. The tiger broke into a gallop and fell dead forty yards further on. The ·577 bullet of solid soft lead had gone through his heart and passed out on the other side.'

The angle at which the animal is standing is important.

'. . . .The panther came to the kill from up hill and appeared about 8 yards from my bush shelter. To the shot from the ·375 rifle he tumbled about, and then made off down hill. There was much

blood, but it was late, and the trail could not be followed for more than a hundred yards. Next morning the panther was seen by men sent to keep an eye on the place. A few men were collected. A man was escorted to a tree up which he climbed to act as a watcher of the hill-side. The cover was bombarded with stones and the panther soon appeared in a small open space before me. I killed him with a bullet from my shot gun. . . .' The panther had been bled white. There was but a little blood left in him, and all the 'fight' was certainly out of him. The bullet had entered his chest at the point intended but, owing to the line of his body being up hill, had emerged between his forelegs and injured no vital part.

Wild Dogs. Do they hunt by night?

This seems to be still an unsettled question. Many sportsmen say that they do not hunt after dark and I am inclined to that opinion, but have insufficient personal observations on which to base an assertion. Colonel Ward has over and over again listened to them while lying awake at night in the jungles. I have had very many all night vigils in machans, in jungles where there were wild dogs, but have not heard them, and natives of all the plains jungles with which I am acquainted have told me they do not hunt by night. Possibly it is on moonlight nights that they hunt and I have not been fortunate enough to hear them.

On two occasions I have seen wild dogs in pursuit of game; once the quarry was a nilgai and the other time a sambur hind. The dogs were running mute. A wild dog busy at a kill over which I was sitting chased off a jackal which came to the feast but he did this without any growls or other sounds.

Wild dog puppies (on another occasion) whimpered with eagerness, when wanting to 'fall-to' on a kill, but were restrained by the warning growl of their mother. That is the only occasion when I have heard the voice of a wild dog, but it is not more than seven or eight times that I have seen them at close quarters.

Do not part with your rifle when out shooting. Carry it yourself:

This occurs to me as a final 'instruction', seemingly as unnecessary as that to 'make sure you are loaded'. But it is often neglected to the undoing of the careless sportsman. When the tigress referred to at the commencement of these notes was to be walked up the heavy 12-bore rifle owned by C was not forthcoming. The coolie carrying it could not be found. Neither in that case nor in the following did the absence of the weapon cause any material difference, but in the latter instance, the consequences might have been disastrous.

A friend was going on a tiger shoot for a few days and I lent him my ball-and-shot gun. He wounded a tiger—two bullets in the stomach—and it was located in a small patch of cover. My friend had a companion with him who, despite the fact of a tiger having been wounded, entrusted the carrying of his rifle to a cooly. When the tiger was located the cooly made himself scarce. There was a shouting and a calling for the absent weapon—the two

sportsmen standing some thirty yards from the cover—when the tiger charged. The first bullet grazed his cheek ; the second, at but a few paces, got him in the base of the throat. It was his presence of mind alone that saved my friend. The tiger was almost on him when he threw himself to one side and thrust the barrels of the gun into the tiger's open jaws. On picking himself up he found the tiger gasping out his life five yards away and his unarmed companion agape behind him.

Suppose the tiger had not been killed ? ! ! !

The left barrel of the gun—an exceptionally heavy weapon with steel barrels—was deeply indented by the canine teeth, which had scored a groove all round it. The sportsman was badly bruised on chest and thigh by the impact of the tiger's body, having probably been struck by the right forearm and stifle of the charging animal.

Apart from the more serious occasions such as the above there can be but few sportsmen who have not missed many opportunities both with gun and rifle for want of the weapon itself being in the hand, or of it being not ready for instant use. 'Lost opportunities seldom recur', or, as Bacon quaintly expresses it, 'Occasion turneth a bald noddle after she hath presented her locks in front and no hold taken.'

These few notes are closed in the hope that some others of our members will venture into the open and add to the general interest of the Journal by relating some of their experiences.

ON THE ANATOMY OF TWO NEW TREMATODES OF THE GENUS *DICROCŒLIUM* WITH A KEY TO THE SPECIES OF THE GENUS

BY

DHARAM NARAIN, M.SC. AND RAM SARAN DAS, M.SC.

Zoology Department, University of Allahabad.

(*With a plate*)

INTRODUCTION

The commonly available lizards in the United Provinces, India, are *Calotes versicolor* Daud., *Hemidactylus flaviviridis* Ruppel and *Uromastix hardiwickii* Gray. All these are found to harbour in their gall-bladder trematodes of the genus *Dicrocœlium*. It is strange that the existence of these parasites has hitherto remained unnoticed though these lizards are generally used for dissection in all laboratories in Northern India. The specimens obtained from *Hemidactylus* and *Calotes* apparently belong to the same species showing only minor differences of size, form, etc., ; but those from *Uromastix* are quite different and have therefore been assigned to a separate species.

The percentage of infection may be gathered from the following table :—

Host	No. of lizards examined	No. of Lizards infected	Percentage of infection
Hemidactylus flaviviridis.	32	1	3·1%
Uromastix hardwickii ...	40	1	2·5%
Calotes versicolor ...	64	10	15%

It has not been possible to examine *Uromastix* from time to time throughout the year, as has been done in the case of the other two lizards, because the former is not easily available. The infection in *Calotes* seems to be the heaviest in the rainy season—one lizard yielding as many as 18 parasites, which is the largest number recorded, and several giving as many as 8 to 10. They were small in size and more or less immature. The number obtained in other seasons is only 2–3 from a single host ; but these specimens are larger and fully mature. This lizard is very vigorous and feeds actively in the rainy season ; it is therefore probable that the infection takes place about this time of the year.

We wish to offer our thanks to Dr. H.R. Mehra and Mr. S.C. Verma of the University Department of Zoology, for their valuable help in connection with this work. We are also very thankful to Mr. S.N. Deb of the Kayasth Pathshala who very kindly translated a few German and French papers for us.

The prepared slides have been deposited in the reserve collection of the Department of Zoology, University of Allahabad.

Dicrocœlium orientalis n. sp.*

External Characters. The body is flattened more or less leaf shaped. It measures 5·5·5 † in length and 2·5–3 in maximum breadth in the region of the ventral sucker. It is greyish with two longitudinal greenish-yellow streaks, one on each side, the colour of the streaks being due to the intestinal cæca

* This account is based mainly on the specimens obtained from *Calotes*.

† All measurements are in mms.

which are full of bile. It is capable of expansion and contraction and changes its shape accordingly. During extension the movements become very clear and the anterior end assumes a pointed appearance.

The oral sucker is situated at the anterior extremity and has a diameter of 0·3864. The ventral sucker lies at about a quarter-length of the body from the anterior end at the level of the intestinal bifurcation. It is a little larger than the oral sucker measuring 0·442 in diameter. The cuticle is thick and devoid of spines. The genital opening contained in a common genital atrium, is situated near the posterior end of the œsophagus, slightly in front of the intestinal bifurcation. The excretory aperture lies at the posterior end.

Digestive System. The mouth is situated ventrally at the anterior end and is surrounded by the prominent oral sucker. It leads into a thick muscular pharynx of 0·10 diameter. The œsophagus is short and bifurcates into the intestinal cæca which terminate in front of the posterior end. Their wall is smooth formed of tall columnar epithelium and surrounded by a layer of circular and longitudinal muscle-fibres. The food consists mainly of bile contained in the cæca, which appear in living specimens as two streaks of greenish-yellow colour.

Nervous System. As usual the nervous system is in a very degenerate condition. The nerve collar lies a little behind the pharynx ; from this minute nerves are given off anteriorly, two on each side. Posteriorly it gives off two main nerves—one running on each side of the body. They give out smaller nerves travelling irregularly to different parts of the body.

Male Genital Organs. There are two prominent, rounded testes 0·365 in diameter. They lie symmetrically one on each side at a distance of one-third body-length from the anterior end in the postero-lateral angle of the ventral sucker, from which they are separated by a distance of about two-thirds of its diameter. In some specimens they extend a short distance in front of the posterior margin of the ventral sucker. From the inner margin of each testis there arises a thin tube, the vas-efferens, which runs obliquely towards the anterior end. The two vasa-efferentia meet each other in the middle line, between the ventral sucker and the intestinal fork, to form a very short vas-deferens. The cirrus-sac is a long cylindrical tube with muscular walls surrounding the cirrus and lying ventrally to the intestine. Within it near its posterior end the vas-deferens becomes dilated into a slightly convoluted vesicula-seminalis which is filled with sperms and occupies nearly one-third length of the cirrus-sac. The cirrus is a thick-walled tube surrounded by the prostate cells situated in the anterior two-thirds of the cirrus-sac. It leads as usual into the genital atrium.

Female Genital Organs. The ovary is rounded and feebly lobed measuring 0·20 in diameter. It is situated in the median line close behind the testes nearer ventral than the dorsal surface. The oviduct arises from it dorsally near the middle and passes towards the right side to join the duct of the receptaculum seminis. It then turns backwards and inwards and after receiving the Laurer's canal on one side and the short duct from the vitelline reservoir on the other opens into the ootype, which is surrounded by the shell-gland of the usual form. The relations of these ducts are shown in Fig. 4. The Laurer's canal is a narrow slightly convoluted tube which has been traced in sections right up to the cuticle of the dorsal body wall. Its external opening being small could not be detected. Close to the ovary on the right side and sometimes overlapping it lies the receptaculum-seminis, which is a somewhat curved elongated sac with thin walls and as usual filled with sperms. The shell gland lies a little behind the receptaculum-seminis close to the postero-lateral angle of the ovary. The vitellaria lie in the middle-third of the body close to the outer margin, one on each side partly overlapping the intestinal cæca. Each gland consists of a large number of close-set follicles lying along a longitudinal axis from which two oblique vitelline-ducts arise on each side. The latter after a short course inwards join together to form small transverse ducts which unite at the prominent vitelline reservoir, situated close to the shell-gland. A short duct from the reservoir connects it with the oviduct as it enters the ootype.

The uterus is a very conspicuous large and coiled tube occupying about three-fourths of the body. It extends anteriorly as far as the intestinal bifurcation and posteriorly to the hindermost extremity and remains confined in the region within the vitellaria. The exact course is difficult to make out because of the overlapping of the various loops. It can be seen however that starting from the

ootype it runs backwards almost to the posterior tip and then curving forwards ascends upwards. It again bends downwards and reaching the posterior end goes upwards. In this way as seen in several preparations, four longitudinal trunks can be marked out to some extent which give out small transversely coiled loops. Ultimately it appears to emerge forwards in front of the ventral sucker, running alongside the cirrus sac to open into the genital atrium. The eggs are at first of a light yellow colour, but soon assume a brownish tinge. They measure 0·03290 × 0·03295.

Excretory System. The excretory bladder is more or less a spherical vesicle of small size measuring 0·4 in diameter. The excretory pore, guarded by sphincter muscles. is terminal and situated at the posterior end. The wall of the bladder consists of a thin layer of muscle-fibres. During life it is filled with the colourless excretory fluid. Into it open the two main excretory ducts each of which is formed by the union of several very minute capillaries ending in flame cells. As the latter are colourless and very minute in size it is difficult to study them except in the living condition. It was, however, easier to observe them in specimens soon after they had died a natural death.

Diagnostic characters of Dicrocœlium orientalis. Body leaf-like. Length 5·0–5·5; breadth 2·5–3·0; oral sucker, terminal, 0·3864 wide. Pharynx immediately behind oral sucker 0·10 in diameter. Œsophagus short bifurcating into prominent simple intestinal cæca which extend almost to the posterior end of body. Ventral sucker circular, diameter 0·442 at one-fourth body length from anterior end. Testes rounded, 0·365 in diameter situated symmetrically along the postero-lateral angle of the ventral sucker. Cirrus-pouch long cylindrical containing a slightly convoluted vesicula seminis behind and a prostate in front. Genital orifice slightly in front of intestinal bifurcation. Ovary rounded, feebly lobed, 0·2 in diameter, median, close behind the testes. Receptaculum seminis located obliquely close behind ovary, Laurer's Canal present. Vitellaria made up of a large number of compact follicles, close to lateral margin in middle third of body. Uterus conspicuous filling up the body between the ventral sucker and posterior end. Eggs small, oval, of light yellow to brownish colour 0·03295 long and 0·03290 wide.

Host. *Calotes versicolor* and *Hemidactylus flaviviridis.*
Location. Gall bladder.
Locality. Allahabad.

Dicrocœlium indica n. sp.

External Characters. Dicrocœlium indica is a distinctly bigger form than *D. orientalis*. It is comparatively thin, transparent and yellowish in colour with black spots due to the coils of the uterus. It measures 6·0–6·5 in length and 2·0 in greatest breadth i.e. in the region in front of the testes. The body of an elongated-ovoid shape has considerable powers of expansion and contraction. The cuticle is thin and devoid of spines. The oral sucker is 0·4583 in diameter. The ventral sucker, situated about one-third the length from the anterior extremity, measures 0·3055. It is noteworthy that the ventral sucker is smaller than the oral, the reverse of what is usually the case in other species of the genus. The genital opening is near the bifurcation of the œsophagus slightly to one side of the median line. The excretory aperture is situated at the posterior end.

Digestive System. It begins with a mouth surrounded by a fairly large oral sucker situated at the anterior end of the animal. The mouth leads into a globular muscular pharynx of 0·1363 diameter, the prepharynx being totally absent. The œsophagus is short and thin walled; it forks into limb-like intestinal cæca lying laterally and extending backwards almost to the posterior end. Outside the intestinal epithelium there lies a clear layer of circular muscle fibres which in its turn is enveloped by a layer of longitudinal muscle fibres. The food of the worm according to its habitat naturally consists of bile which gives the intestinal cæca a greenish-yellow colour.

Male Genital Organs. The testes are symmetrical, lying immediately behind the ventral sucker at the level of its posterolateral angle and are separated from it by a distance of three-fourths of its diameter. They are generally rounded in appearance but the shape varies in different preparations owing to their having

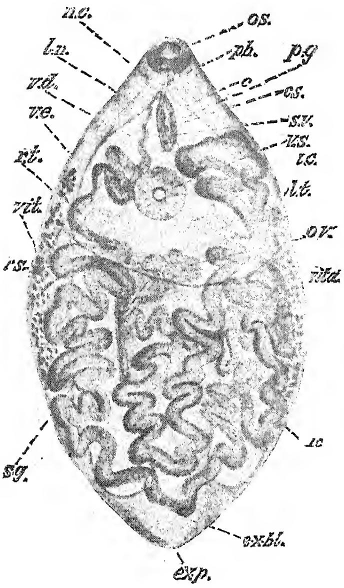

Fig. 1

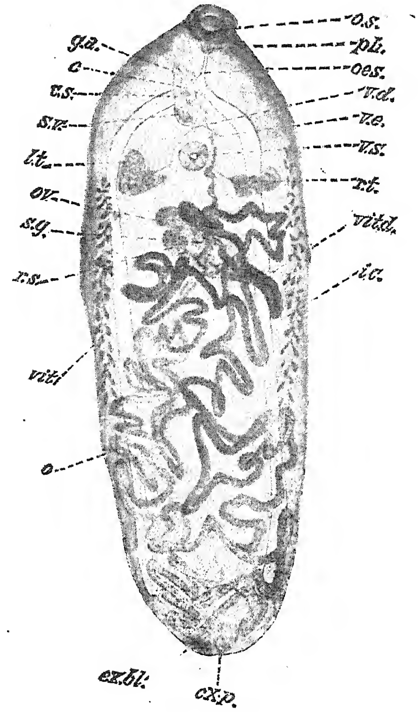

Fig. 3

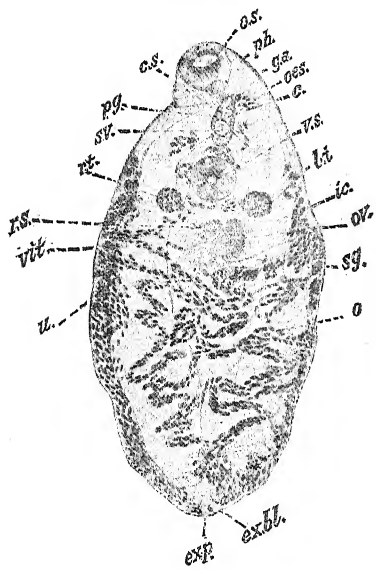

Fig. 2

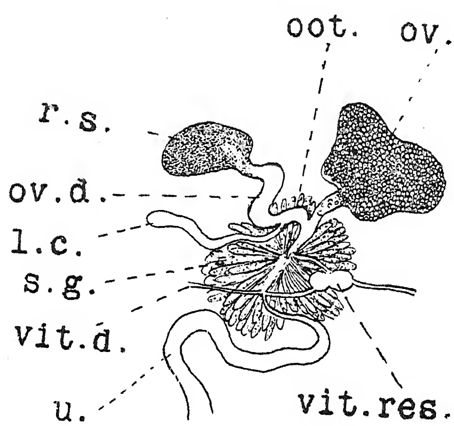

Fig. 4

Fig. 1. *Dicrocœlium orientalis* n. sp. (from *Calotes versicolor*), ventral view.
,, 2. *Dicrocœlium orientalis* n. sp (from *Hemidactylus flaviviridis*) ventral view.
,, 3. *Dicrocœlium indica* n. sp. (from *Uromastix hardwickii*) dorsal view.
,, 4. A diagrammatic sketch showing the relations of female genital organs in *Dicrocœlium orientalis* n. sp.

Explanation of Lettering

c.	= cirrus.	oes.	= œsophagus.	r. t.	= right testis.
c. s.	= cirrus sac.	o. s.	= oral sucker.	s. g.	= shell gland.
ex. bl.	= excretory bladder.	oot.	= ootype.	s. v.	= seminal vesicle.
ex. p.	= excretory pore.	ov.	= ovary.	u.	= uterus.
g. a.	= genital atrium.	ov. d.	= oviduct.	v. s.	= ventral sucker.
i. c.	= intestinal cæcum.	ph.	= pharynx.	vit.	= vitellarium.
l. c.	= Laurer's canal.	p.g.	= prostate gland cells.	v. d.	= vas defrens.
l. n.	= lateral nerve.			v. e.	= vas e erens.
l. t.	= left testis.	r. s.	= receptaculum seminis.	vit. d	= vitelline duct.
n. c.	= nerve collar.			vit. res.	= vitelline reservoir.
o.	= ova.				

been pressed. The left testis is always somewhat bigger than the right one. The dimensions of the two testes of the same specimen are as follows :—

Right testis	...	...	0·376 by 0·282.
Left testis	...	...	0·4653 by 0·282.

The vasa-efferentia arise from the anterior side of the testes and run obliquely forwards to form a very short vas-deferens at the hinder extremity of the cirrus sac. It continues into a wider thin-walled convoluted vesicula-seminalis occupying nearly two third length of the cirrus sac. As seen in entire mounts through the walls of the cirrus-sac it is densely packed with sperms of the usual type. The cirrus, a highly convoluted tube, lies in direct continuation of the vesicula seminalis in the anterior third of the cirrus sac, and is surrounded by some feebly developed prostatic cells. It is much elongated, has thin transparent walls and measures 0·3055 in length and 0·282 in breadth.

Female Genital Organs. The ovary is median lying just behind the line joining the posterior margins of the testes. It is rounded and has an irregular outline measuring 0·2256 by 0·1645. It is closely followed by the receptaculum seminis which it somewhat overlaps. The latter is thin-walled and about two-third the size of the ovary. The shell gland composed of the usual type of granular cells abuts on the posterior margin of the receptaculum seminis. It has nearly the same dimensions as the ovary. On account of the close proximity of these organs and the paucity of material the exact relations of the oviduct, the duct of the receptaculum seminis and the Laurer's Canal could not be seen.

The vitellaria are more feebly developed than in *Dicrocœlium orientalis* and approximately fill the middle third of the body. They lie laterally as thin bands one on each side of the body and are composed of widely separated follicles which are connected by a narrow central branching strand. A transverse vitelline duct is given off from about the middle of each vitellarium; and passes inwards as a more or less straight tube, to meet its fellow of the opposite side in the region of the shell gland, forming a very small inconspicuous vitelline reservoir.

The uterus is very much convoluted and occupies the same relative position in the body as in the previous species-filling up the entire space between the ventral sucker and the posterior extremity of the body. Its loops are more transversely elongated than those of the uterus of *D. orientalis*. It emerges in the vicinity of the ventral sucker as a narrow slightly convoluted tube with eggs of 0·044 by 0·024 size arranged in a single row and then passes to the outer side of the body crossing the vasa-efferentia a little behind the cirrus sac. Finally it curves and running alongside the cirrus sac opens into the genital atrium.

Excretory System. The excretory bladder is fairly large situated at the posterior end of the animal. In pressed specimens it appears of an irregular triangular shape. It opens outside by a minute aperture situated at the hinder extremity. Anteriorly it receives two main excretory tubes one on each side. The rest of the excretory system is of the usual type.

Diagnostic Characters of D. indica. Body thin, leaflike length 6·0-6·5; breadth 2·0. Oral sucker terminal, large 0·4583 wide. Pharynx thick, muscular 0·1363 in diameter. Œsophagus short; intestinal forks simple, extend posteriorly to nearly the hindermost end. Ventral sucker smaller than oral, 0·3055 in diameter at one-third body length from anterior end. Testes symmetrical along postero-lateral margin of ventral sucker; generally rounded but of variable shape, size unequal left one 0·4653 in diameter right one 0·376 in diameter. Cirrus sac elongated; vesicula seminalis convoluted occupying two-third of the sac: the anterior one-third containing the highly convoluted cirrus surrounded by a few faint prostatic cells. Genital opening just in front of intestinal bifurcation, slightly to one side of median line. Ovary irregularly rounded, behind testes of 0·2256 × 0·1645 size. Receptaculum seminis smaller than ovary partly overlapped by it. Shell gland abutting on posterior margin of receptaculum seminis. Vitellaria feebly developed with widely separated follicles not quite filling the middle third of body. Uterus highly convoluted between ventral sucker and posterior extremity. Eggs small oval of dark brown colour 0·044 long 0·024 wide.

Host. *Uromastix hardwickii.*

Location Gall bladder.

Locality. Allahabad.

TABLE SHOWING THE CHARACTERISTICS OF

Species	Host	Size and shape of the body	Size and ratio of suckers oral to ventral	Pharynx	Intestinal cæca	Testes
1. *D. petiolatum* (Railliet 1900).	Liver and gall bladder of *Garrulus glandarius.*	Fusiform elongated L.—6-7·5. B—0·7-0·84 in front of testis near V.S. neck about 1·5 long.	O.S. 0·30 V.S. 0·60×0·8 elliptical. O.S. : V.S., : : 3 : 8.	0·145 long.	End 1·6 before the tapering hind end.	Rounded, somewhat larger than the ovary situated one behind the other posterior to the V.S.
2. *D. albicolle* (Rudolphi 1819).	(A) *Corvus cornix*, *Pica pica.* (B) *Aquila pennata.*	(A) body fusiform very long posterior extremity obtuse. L.—11-12 B.—0·9-1·16 (B) L—6·0. B—1·0.	(A) O.S. 0·4-0·45 V.S. 0·85-0·95 O.S. : V.S. : : 1 : 2. (B) O.S. 0·312 V.S. 0·312—0·390 O.S. : V.S. : : 1 : 1.	(B) globular close behind the O.S. 0·092 × 0·083.	(B) reach upto the posterior end of the body.	(B) oblique one behind the other posterior to the V.S.
3. *D. dellectens* (Rudolphi 1819).	*Thryothorus hypoxanthus.*	Oblate, broad lancet shaped anterior end rounded and posterior end conical.	O.S.—L-0·240 B-0·281 V.S.—L-0·364 B-0·333 the V.S. is at a distance of 1/3 body length from the anterior end.	Globular 0·104.	Short, reaching only upto the middle of the body.	Rounded, lie symmetrically beside one another 0·208 just behind the V.S.
4. *D. delectans* (Braun 1901).	Intestine of *Myiothera ruficeps* (Brazil).	It has a small conical neck attached to the broad body which tapers posteriorly. L—2·8 ; B 1·0.	O.S.—L.—0·198 B.—0·240 V.S. 0·350 in diameter O.S. : V.S. : : 2 : 3.	...	Overlap the vitellaria a little and do not reach the hind end.	Globular or longitudinally oval symmetrical beside or behind the V.S. somewhat smaller than it.
5. *D. voluptarium* Braun 1901).	Intestine of *Falco* sp.	......	O.S. subterminal circular 0·229 in diameter V.S. with thrice or more diameter of O.S. O.S. : V.S. : : 1 : 3 suckers very much near each other.	L.—0·07 B.—0·09	End behind the middle between the hind edge of the body and the vitellaria.	Oval or more or less circular symmetrical beside or behind the V.S.
6. *D. reficiens* (Braun 1901).	Intestine of *Falco nitidus.*	It has a short neck, the hind body is long. L.—4·00 B.—0·75	O.S 0·344 not perfectly circular V.S., 0·40 in diameter O.S. : V.S. : : 3 : 4.	L.—0·114 B.—0·156	Wide towards the head part, do not wholly reach upto the hind end.	Rounded smaller than the V.S. lying symmetrically behind it.
7. *D. lubens* (Braun 1901)	*Pipra rupricola.*	Anterior end pointed. Posterior end more or less rounded. The two suckers are very much near each other.	O.S. 0·364. V.S. 0·470. O.S. : V.S. : : 3 : 4.	Globular 0·104 in diameter.	Could not be traced.	rounded lying symmetrically behind the V.S. smaller than V.S.

O. S.—Oral Sucker. V. S.—Ventral Sucker.

THE SPECIES OF THE GENUS *DICROCŒLIUM*

Cirrus	Ovary	Vitellaria	Uterus	Genital pore	Eggs	Remarks
L. 0·34 B. 0·11	Smaller than the testes, a little behind them.	Consist of large rounded or pear-shaped follicles which lie thick beside and behind one another. They begin directly behind the testes and reach upto the second-third of the body length 2·0-2·5.	Spreads out behind the testes in transverse loops in the entire middle field reaching outwards upto the vitellaria and posteriorly upto the intestinal cæca. The folds do not reach the hindermost end of the body.	Posterior to pharynx.	Brownish not very thin shelled L.—0·045-0·050 B.—0·027-0·029.	...
...	...	(B) Lateral not equally well developed on both the sides begin behind the V.S. and reach scarcely behind the middle of the body.	(B) In transverse loops very thickly packed.	(B) in the neighbourhood of the pharynx.	Dark brown thick shelled and inflated 0·0246 in diameter.	(A) According to Railliet. (B) According to Braun.
Short and compact.	Smaller than the testis behind one of them,	Lateral and slender beginning in a line with the testes and extending to about two-thirds of the body length.	In transverse loops in the back half of the body.	In front of the pharynx in the middle line.	Dark L.—0·0228-0·0273 B.—0·014-0·0160	...
...	Oval with its longitudinal axis transversely placed.	Reaching upto the testes anteriorly and extending back-wards posteriorly upto 1.4.	Well-developed reaching upto the posterior tip of the body.	Lies at hind end of the pharynx.	Brown moderately thick shelled L.—0·0228-0·0273 B.—0·014-0·0182.	...
Cirrus sac can lie under the V.S. L.—0·200 B.—0·125	Oval or quadrilobed with its longitudinal axis transversely placed close behind one of the testes.	Begin before near the anterior end of the testes and finish in the middle of the body.	Occupies the entire body behind the testes reaching the posterior tip of the body.	Lies at the hind end of the pharynx.	Young eggs clear old dark brown not very thick shelled 0·032×0·0228.	...
...	Rounded as big as the testis but smaller than V.S. lying behind one of the testes.	Begin before the testes in the level of the middle of the V.S. extend only a little over the middle of the body.	A little inflated its coils fill up the entire space behind the testes upto the end of the intestinal cæca.	...	Brown thick shelled L.—0·032-0·0364 B.—0·182.	...
...	Much smaller than the testes.	Begin at the level of the V. S. and extend posteriorly beyond the middle of the body.	Very strongly developed transverse loops almost reach the body wall. Anteriorly it extends upto the ovary and posteriorly to the hindermost region of the body.	...	Young eggs yellow older ones black brown thick shelled. L.—0·0320. B.—0·0228.	...

L.—Length. B.—Breadth.

TABLE SHOWING THE CHARACTERISTICS OF

Species	Host	Size and shape of the body	Size and ratio of suckers oral to ventral.	Pharynx	Intestinal cæca	Testes
8. *D. illiciens* (Braun 1901)	*Rhamphastus* sp. *Pipra rupicola*.	Body oblate with a short conical neck, hind end broad gradually getting narrower. L.—6·0 B.—2·0 just in front of the testes.	O.S. subterminal circular 0·510 in diameter V. S. circular 0·700 in diameter. O.S. : V.S. : : 5:7	Globular 0·162 in diameter.	Do not reach the hind end.	Large longitudinally stretched, lobed lying symmetrically in a line with V.S. but extending slightly behind it.
9. *D. macrostomum* (Ohdner 1911).	Bile duct of *Numida ptilorhyncha*.	L.—3·65—4·75 B.—1 —1·5 The greatest breadth as with *D. lanceolatum* in the posterior part of the body thickness 0·4.	O.S. 0·28—0·33. V.S. 0·19—0·23· O.S.: V.S. : : 4: 3.	0·07-0·09 in diameter.	Reach upto 2/3 the length of the body.	More or less lobed, obliquely arranged behind V.S. bigger than V.S.
10. *D. clathratum* (Deslongchamps, non Olsson) (*Distomum refertum* Muhling)	*Cypselus* (*Apus*) *apus* *Sylvia atricapilla*.	Elongated cylindrical broadest in the middle, narrow towards the ends. L. 2·64-3, 4-4·5. B. 0·6 -0·66.	O.S. 0·2—0·255. V.S. 0·4—0·435. O.S.: V.S. : : 1:2.	0·078 in diameter.	Reach near the posterior end.	Small rounded symmetrically placed behind the V. S. 0·1044 in diameter.
11. *D. olssoni* (Distomum *Clathratum* Olsson et Muhling)	Gall bladder of *Cypselus* (*Apus*) *apus*.	Elongated, cylindrical Broadest in the region of the V. S. rounded posteriorly. L. 2·0—2·25. B. 0·5—0·2-0·525	O.S.—0·09—0·105 -0·135. V. S.—0·28—0·315 -0·39. O.S. : V.S. : : 1:3.	Small 0·075 in diameter.	Reach the middle of the body.	Rounded or elliptical diameter 0·255-0·285 partly over-lapping one another, the anterior one often dorsal to V.S.
12. *D. panduriforme* (Railliet 1900).	*Pica pica*.	L.—3·6. B.—1·0. Posterior end obtuse	O.S.—0·32 V.S.—0·50 O.S. : V.S. : : 3 : 5.	...	...	Testes one behind the other posterior to the V.S.
13. *D. attenuatum* (Durjardin 1845).	*Turdus merula*.	Body Sublinear L.—3·50. B.—0·22.	...	...	...	Situated one behind the other.
14. *D. lobatum* (Railliet 1900).	*Accipiter nisus*.	Body very elongated posterior extremity obtuse L.—7·5-9·5 B.—0·38-0·4.	...	...	...	Elliptical one behind the other posterior to the V.S.
15. *D. dendriticum* (Rudolphi 1819).	Bile duct of herbivorous and omnivorous mammals (sheep, ox, goat, ass, horse, deer, hare, rabbit, and p .)	Lancet-shaped L.—8-10 B.—1·5-2·5 greatest breadth usually behind the middle of the body.	O.S.—0·5 V.S.—0·6 Suckers separated from one another by a distance of about 1/5 the length of the body O.S. : V.S. : : 5: 6.	Globular adjoining the O.S.	Reach 4/5 of the body length.	The large slightly lobed testes lie obliquely one behind the other posterior to the V.S.

O. S.—Oral Sucker. V. S.—Ventral Sucker.

THE SPECIES OF THE GENUS *DICROCŒLIUM*—(*continued*)

Cirrus	Ovary	Vitellaria	Uterus	Genital pore	Eggs	Remarks
L.—0·470. B.—0·260.	Bean-shaped behind one of the testes.	Small in proportion to the size of the creature, length about 1·0 only a little longer than the testes.	Completely fills the posterior half of the body.	Close behind the pharynx.	Very numerous fairly thick shelled dark brown. L.—0·0364. B.—0·0228.	...
...	Of changing form globular or lobed.	Short 0·5—0·65 in the middle of the body built up of a few relatively large follicles.	...	Ventral to pharynx.	L.—0·04-0·043 B.—0·026.	...
...	Oval small situated behind one of the testes. L.—0·1600. B.—0·0864.	Long in the middle third of the body.	Coiled between the V.S. and the posterior end.	...	L.—0·0396-0·0468 B.—0·025-0·0312.	Laurer's canal present with median external opening.
...	Ellipsoidal close behind the testes diameter 0·145.	Short between ovary and the middle of the body.	As usual coiled from in front of V. S. to the posterior-most end.	...	L.—0·034-0·036. B.—0·0170-0·0198	Laurer's canal present, opening to the outside.
L.- 0·14 B.—0·07	As big as the testes, a little behind the second testis.	Continuous band 1·25-1·55.	...	Behind the pharynx.	L.—0·42-0·45 B.—0·02-0·025.	...
...	Ovary small.	Commence behind the ovary L.—0·5.	...	...	L.—0·036-0·039 B.—0·020-0·022.	...
L.—0·16 B.—0·06	Globular notably very small, situated a short distance behind the V.S.	Formed of a small number of large follicles occupying a length of 1—1·4 behind the ovary.	...	...	L.—0·047-0·50 B.—0·028-0·030.	...
Small and slender.	Rounded smaller than the testes placed behind the posterior testis.	Commence at the level of the posterior testis and extend to near the posterior third of the body.	Extends throughout the posterior end. It is not confined to the central field but overlaps the lateral fields with its transverse coils.	At the level of the bifurcation of the intestine.	Thick shelled brown 0·038-0·045 × 0 022-0·03.	...

L.—Length. B.—Breadth.

TABLE SHOWING THE CHARACTERISTICS OF

Species	Host	Size and shape of the body	Size and ratio of suckers oral to ventral	Pharynx	Intestinal cæca	Testes
16. *D. lanceatum* var. symmetricum (Baylis 1918).	Cat.	L.—5-7 B.—1·62-2·0 posterior end pointed.	O.S.—0·37 V.S.—0·40 O.S. : V.S. : : 7 : 8.	...	...	Lie symmetrically behid the V. S. bigger than V.S. L.—0·8 B.—0·6.
17. *D. infidum* (De Faria).	Gall bladder of Brazilian Snake (*Eunectes murina*).	L.—3-3·5 B.—2·0-2·2 caudal extremity covered with small slender spines upto the acetabulum.	O.S.—0·422×0·548 V.S. round 0·580 in diameter O.S. : V.S. : : 1 : 1.	...	...	L.—0·528 B.—0·294 lobed lying symmetrically in a line with the V.S. but extending behind it to some extent smaller than V.S.
18. *D. conspicuum* (De Faria)	Gall bladder of *Mimus lividus*.	L.—7-8. B.—3·0-3·5.	O.S. 0·55--0·62. V.S. 0·85. O.S. : V.S.:: 3:5.	0·2-0·22	...	Lobed symmetrically arranged behind the V. S. L.—0·76-0·86. B.—0 60-0·73.
19. *D. orientalis* n. sp.	*Calotes versicolor* and *Hemidactylus flaviviridis*.	L. 5-5·5. B. 2·5-3·0.	O.S. 0·3864. V.S. 0·4420. O.S. : V.S.:: 3:4.	Diameter 0·10.	Do not reach the posterior end.	Symmetrically arranged behind the V.S. diameter 0·4596.
20. *D. indica* n. sp.	*Uromastix hardwickii*.	L. 6-6·5. B. 2·0. Elongated ovoid shape.	O.S. 0·4583. V.S. 0·3055. O.S. : V.S. :: 3 : 2.	L.—0·1363 B.—0·1692	Reach almost to the posterior end.	Symmetrically arranged behind or at the level of the posterior half of the V. S. transversely elongated. 0·376 × 0·282.

O. S.—Oral Sucker. V. S.—Ventral Sucker.

THE SPECIES OF THE GENUS *DICROCŒLIUM*—(*concluded*)

Cirrus	Ovary	Vitellaria	Uterus	Genital pore	Eggs	Remarks
0·4×0·15	Shape variable usually lobate position also variable more commonly on the right than on the left.	...	Uterine coils show complete agreement with those of the foregoing species.	...	Blackish or brownish slightly larger than the average size of the egg roundish oval 0·0425–0·050×0·03.	...
...	Diameter 0.260.	...	Uterus very coiled.	...	...	...
...	0·36–0·48.	...	...	...	0·04 × 0 022.	...
Cirrus sac. long and cylindrical, vesicula seminalis slightly convoluted	Rounded and feebly lobed diameter. 0·2688.	In the middle third of the body follicles close set.	Very coiled, extends forwards in front of V. S. and backwards to nearly the posteriormost tip.	Near the posterior end of the œsophagus.	Brown 0·0329 × ·03295.	Excretory bladder spherical 0·4 in diameter Laurer's canal present.
Cirrus sac. 0·3055 × 0·2820 prominent vesicula seminalis.	Small rounded behind the testes in the median line. 0·2256 × 0·1645.	From V. S. to near the end of the middle third of the body.	Highly convoluted between the ovary and the posterior extremity.	Behind the œsophagus just in front of the intestinal bifurcation.	Brown 0·044 × 0 024.	Excretory bladder long and more or less lobed.

L.—Length. B.—Breadth.

Genus *Dicrocoelium.*

- Testes symmetrically arranged.
  - Testes rounded
    - Oral sucker larger than ventral — *D. indica*, n. sp.
    - Oral sucker smaller than ventral
      - Ovary in the median line. — *D. orientalis*, n.sp.
      - Ovary behind one of the testes.
        - Ovary lobed. — *D. voluptarium.*
        - Ovary not lobed.
          - Ovary oval. — *D. clathratum.*
          - Ovary rounded.
            - Vitellaria not reaching ventral sucker.
              - Vitellaria short — *D. deflectans.*
              - Vitellaria long. — *D. delactans.*
            - Vitellaria reaching upto ventral sucker.
              - Uterus not very compact. — *D. reficiens.*
              - Uterus very compact — *D. lubens.*
  - Testes lobed.
    - Cuticle with spines. — *D. infidum.*
    - Cuticle devoid of spines.
      - Ovary behind one of the testes. — *D. illiciens.*
      - Ovary in the median line. — *D. conspicuum.*
- Testes one behind the other.
  - Testes rounded.
    - Ovary as big as the testes. — *D. panduriforme.*
    - Ovary smaller than the testes.
      - Vitellaria very short measuring 1/7 the body length. — *D. attenuatum.*
      - Vittelleria not very short.
        - Intestinal cæca reach upto 3/4 the body length, uterus does not reach up to posteriormost end. — *D. petiolatum.*
        - Intestinal cæca reach upto ½ of the body length, uterus reaches upto the posteriormost end — *D. olssoni.*
  - Testes lobed.
    - Oral sucker smaller than ventral.
      - Vitellaria small measuring nearly 1/7 the body length. — *D. lobatum.*
      - Vitellaria big.
        - Intestinal cæca reaching upto the posteriormost end. — *D. albicolle.*
        - Intestinal cæca reaching upto 4/5 the body length. — *D. dendriticum.*
    - Oral sucker bigger than ventral. — *D. macrostomum.*

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THE STUDY OF PLANT LIFE

BY

CHARLES McCANN

Asst. Curator, Bombay Natural History Society

PART III

(*With 1 plate, 2 blocks and 26 Text-figures*)

(*Continued from page 46 of this Volume*)

THE LEAVES

The popular conception of the term leaf might be taken as a word descriptive of the foliage of a plant. A more precise, a more scientific definition of the term includes yet other portions of the plant not usually included in this category. The Botanist associates with leaves all the organs of a plant which appear as lateral out-growths from the stem. The term leaf then includes the cotyledons which protect the seed, the scales, bracts, spines, tendrils and even the flowers. In this view every part of the plant except the roots or the stem is either a leaf, or is composed of leaves more or less modified and transformed. For the purpose of our study we will divide leaves under four main headings, Scales, Foliage, Bracts and lastly Flowers.

Scales

In a former part when discussing the roots of plants, reference was made to the scales which cover a rhizome. Their purpose, as we have seen, is mainly protective—a device which enables the growing plant to withstand the inclemencies of the weather during the early stages of its development. At a later stage we find a similar defence provided for the leaves ; we discover the same formation of scales designed to guard them during the critical period of their development.

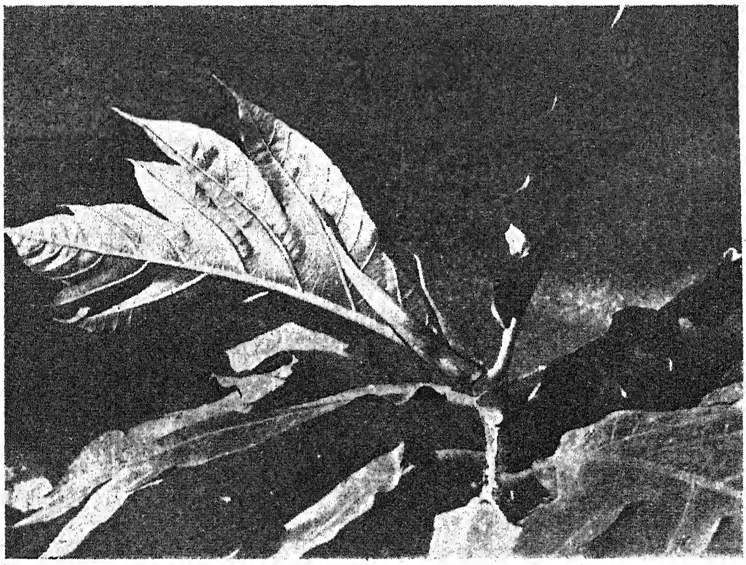
These scales are known as scale-leaves. The tender fronds of many ferns afford striking examples of scale-covered leaves. The unfurling leaf is covered with a brown, dry, chaff-like substance which protects the tender green tissue. Under the lens this investment is seen as a coating of scales—the *scale-leaves*. In some species such as the great tree fern of our evergreen forests the individual scales can be seen with the naked eye. Occasionally they persist throughout the life of the plant.

Scale-leaves are developed particularly by plants which are exposed to the rigours of winter or to the scorching heat and winds of the desert. When conditions are favourable for growth the leaves burst through and the scales fall away.

Stipules

In tropical countries where plants are not exposed to marked vicissitudes of season and climate, there is less urgent need for protection and scales are rarely developed. Their place is taken by appendages of the leaves known as *stipules*.

Normally the stipules are two in number. They grow on each side of the leaf-stalk. In the Rose they form appendages to the enlarged base of the leaf-stalk. Occasionally two stipules may unite or they may completely enclose the stem and then form a sheath (*ochrea*) around the young undeveloped leaves, This sheath-like fusion of the stipules is commonly seen in various species of figs. It is instanced in our common fig, the Banyan (*Ficus bengalensis*). The pinky sheath-like caps which form the apex of the sprouting shoots of a Banyan are the stipules. They enclose and protect the immature leaves. Many such stipules may be found



LARGE STIPULE OF BREAD-FRUIT TREE

one enclosed within the other. Each guards its nursling leaf. As soon as the leaf is strong enough to stand exposure to the sun it commences to unfold. The pressure forces the stipule upward. The leaf has no further need for protection. The stipule is shed. Stipules thus shed are spoken of as *deciduous*. When they remain attached to the plant for a protracted period they are termed *persistent*.

Stipules as I have indicated vary in form and structure. In the Cassias, a genus which provides so many beautiful road-side trees, they are very leaf-like. They might readily be mistaken for leaflets. In some plants stipules are so small and insignificant that they are easily overlooked. In others, as in the Banyan, they are large and conspicuous. The position of the stipules sometimes provides an important means of distinguishing between various orders of plants. Exact terms descriptive of the position of the stipules are therefore brought into use. A stipule emerging from the base of the leaf in the region of the axil is termed *axillary*. When it originates between the stalks of two opposite leaves it is called *interpetiolar*. When stipules are absent, as in the majority of Monocotyledons, the leaves are described as *exstipulate*.

Stipules may perform for the plant other functions than those of a purely protective nature. In the Cassias they perform the function of leaves. They are modified in other species to form spines, while in some climbing plants they appear as tendrils on either side of the leaf stalk and assist the plant in obtaining a hold.

Foliage Leaves

Our study of foliage leaves must begin with the manner of their origin and development. The leaf commences as a tender, delicately folded bud. Its development as such reveals one of the marvels of Nature's handicraft. We can understand a loom weaving a material and folding it up after completion. But to produce and complete the intricately folded material as such would be a much more difficult achievement. This is nevertheless what happens in the case of leaves. They complete their development while folded and open out when the process is complete! The manner and pattern of folding assumed by the developing leaf is called *Vernation*. There are different types of vernation, more or less intricate. Each species follows a particular pattern. The various forms of vernation can therefore be described by particular terms. The tender fronds of a fern are rolled in a coil from tip to base. This type of folding is called *circinate*. Leaves rolled up from one side to the other into a simple tube are *convolute*. Again the outer margins of the leaf may be rolled inwards towards the midrib. This is *involute* folding. Reverse the process and roll the margins outwards (i.e. on the undersurface) and we have *revolute* vernation. The leaves of palms are folded lengthwise like a fan. This is *plicate* folding. The simplest type of vernation is seen in the Bauhinias. The wings of the leaf are folded flat against each other, like the pages of a book; this form of vernation is called *conduplicate*.

Leaves do not grow at random on a plant. There is order in Nature! Her laws are ordained for the preservation of the species. Leaves have a definite function to perform. They are the 'lungs' of the plant, its organs of respiration and transpiration. They absorb the life-giving light. If the leaves are to do their work efficiently, their surfaces must be so placed as to take the fullest

advantage of light. The existence of the plant depends on it. Their manner of growth on a plant must therefore follow a set arrangement, though the unpractised eye is unable to discern it.

The arrangement of leaves on the stem and branches of a plant is technically known as *Phyllotaxy*. Let me illustrate a few examples. Take the stem of a Sunflower with leaves *in situ*. If a thread be tied to one of its leaf-stalks and trained to follow the leaves in the order of growth, it will be seen that the leaves are arranged in a spiral round the stem. If looked at above or compressed they would form a rossette. By this arrangement no leaf entirely covers the one growing below it. Each gets its fullest share of sunlight. The leaves are thus disposed in *cycles*.

If the leaves are numbered in order of growth as 1, 2, 3, 4, etc. it will be found that leaf No. 1 is directly below No. 6. Thus two cycles or spirals were completed before No. 6 was reached. This arrangement in cycles enables us to describe the manner of leaf growth in mathematical terms. The example I have just given in which two cycles are formed between the first and the sixth leaves is described as a $\frac{2}{5}$ spiral. The numerator 2 denotes the number of spirals described. The denominator 5 indicates the number of leaves passed before a new series is commenced. If the spirals are continued it will be found that the 11th leaf is exactly over the sixth, the seventh over the second, the eighth over the third and so on (see diagram, Fig. 1).

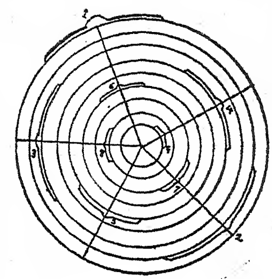


Diagram : FIG. 1.

The point of emergence of a leaf is called its *point of insertion.* Leaves are inserted at various parts of the stem and branches—we define their placement by exact terms. Leaves are called *radical* (L. *radix*=root),when they arise at or below the ground. Such leaves appear to spring directly from the root, in reality they originate from a much compressed and shortened stem which forms the root base. Leaves which spring from a normal stem are termed *cauline* (L. *caulis*=stem). Stemless plants, the Dandelion and Primrose for examples are called *acaulescent* (G. *a*=without, *kaulos*=stalk). Leaves which grow on the branches are called *ramal* (L. *ramus*=a branch).

The ' Ak ' (*Calotropis gigantea*), a common species remarkable for the profusion of milk sap which it exudes on injury, provides an example of leaf arrangement that is very frequent. It is known as *decussate* (L. *decussatum*=divided crosswise in the form of an x). The leaves grow in pairs, each pair crossing the other at right angles.

In grasses we have a different system of leaf arrangement. The leaves are disposed in two rows on the opposite sides of the stem, the disposal of grains on a ear of barley illustrates this arrangement —it is called *distichous* (G. *dis*=twice, *stichos*=a row). A three ranked arrangement is *tristichous.*

When more than two leaves are produced on each node and are arranged radially, they are described as *whorled*. These are a few examples of leaf arrangement—many others could be cited. There is much variation. But however dissimilar the order of leaf growth may appear in different plants, the varying systems are conceived with one purpose in view—the advantageous exposure of the leaf surface to light.

The great majority of plants bear leaves, a few are able to exist entirely without them. The Cacti are examples. Our prickly Spurge (*Euphorbia*) though not a cactus might be included in this category. It is leafless for the greater part of the year. The fierce heat and scorching winds of the deserts where Cacti flourish would soon wither and destroy leaf growth and would put these delicate organs out of action. The important functions normally carried out by the leaves are in this instance performed by the stems which are provided with the necessary green matter—the *chlorophyll*.

Parasitic plants—root parasites in particular—afford better examples of leafless growths. These parasites derive their subsistence from their hosts upon whom devolves the labour of providing and nourishing their uninvited guests. The parasites are thus able to dispense with leaves. The all-pervading Dodder (*Cuscuta reflexa*), a knotted mass of stringy yellow stems, which invests and destroys shrubs in our gardens is an example. The Purple Pipe (*Æginetia indica*), which resembles a tobacco pipe in shape is yet another illustration. These parasites are devoid of leaves and at the same time of green colouring matter. Hence they are entirely dependent on their hosts. The *Loranthus*, so common on Mango and other trees, and the various Mistletoes (*Viscum*) are not wholly parasitic; they possess chlorophyll and are able to provide part of their own nourishment.

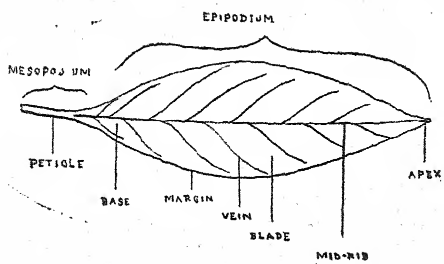


FIG. 2.

Diagramatic figure of a leaf showing the different parts.

Let us now consider a leaf in its simplest form. A leaf is a flat usually green expansion growing from a stem or root-stock and collectively constituting a plant's foliage. The leaf of a Banyan provides an example for study. It is attached to the branch by

a narrow stalk—the *petiole* or *Mesopodium* (G. *mesos*=middle, *pous*=foot). The petiole supports the expanded leaf-blade, in technical parlance the *Epipodium* (G. *epi*=upon, *pous*=the foot) or *Lamina*. The base of the petiole thickens at its point of union with the branch. There is a distinct swelling of the leaf-stalk to form a sort of cushion, the *pulvinus*. This is not developed to a very marked extent in the Banyan leaf. When the base of the leaf stalk is broad the pulvinus may occupy a considerable portion of the stem. The detachment of such a leaf leaves a distinct scar on the stem. With some leaves the cushion is developed to form a sheath which almost encircles the stem or completely encloses it. Definite terms are used to describe these characters.

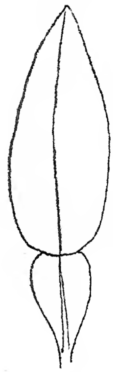


FIG. 3. Wing of petiole of Orange.

The accompanying diagram (Fig. 2) illustrates the terms used in describing the various parts of a typical leaf. All these parts are subject to considerable variation and modification in different species of plants. The petiole may be absent, *Sessile* in stalkless leaves, or it may vary in form and length. In some instances, as in the Orange-leaf, the petiole is broadly winged—almost leaf-like (Fig. 3.) In a few of the Australian Acacias the leaf-blades are short-lived and are not developed at all in the mature tree. The functions of the leaf are then performed by the leaf-stalk and these leaf-like petioles are called *Phyllodes* (Gr. *phullon*= a leaf, *eidos*=resemblance). When, as in the Cacti, the function of the leaf is carried out by the stem the term *Phylloclade* is used. Care should be taken not to confuse the two words, phyllode and phylloclade. The leaf stalk is not always attached to the basal end of the leaf. In the Caladium or in the leaves of the water-lilies the attachment is towards the middle. The term *peltate* (L. *pelta*=shield) describes this form of attachment (Fig. 4.)

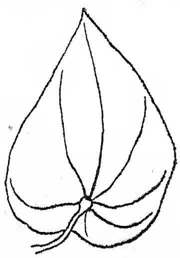


FIG. 4.

Simple and Compound Leaves

The Banyan leaf, which we have taken as our model, presents itself as a simple flat expansion—it is not divided into a number of smaller parts or segments. It is a *simple leaf*. Take another common leaf—that of the Gold Mohur tree (*Poinciana regia*). Here we have a more complicated type of structure. There is a main axis or *rachis* which supports a large number of small blades or leaflets. It provides us with an example of a *compound leaf*. How are we to distinguish between a simple and a compound leaf?

When discussing the development of branches it was shown that every branch originates from a bud situated in the axil of a leaf. The axillary bud indicates the point of union of the leaf-stalk

with the stem. The lateral outgrowth from this point constitutes the leaf. If this outgrowth takes the form of a single expansion it forms a simple leaf, if composed of a number of small blades or leaflets, it is a compound leaf.

Compound leaves exhibit infinite variation. We describe them by precise terms, a knowledge of which is indispensable to the study of plant life. These terms form the basis of any written description of a particular species, genus, family or order of plants. I illustrate some of the more important examples.

Take an Acacia leaf—it is comparable in its composition to a feather. We have the central stem, the *rachis*, representing the

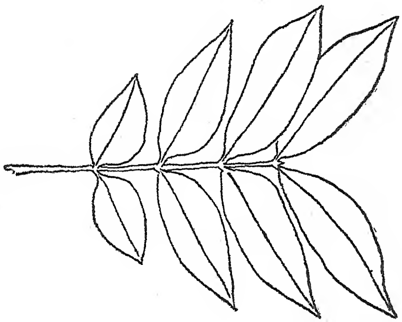


FIG. 5.

quill, to which are attached the leaflets arranged in pairs. This type of leaf is described as *pinnate* (L. *pinna*=feather). Pinnate leaves present themselves in different forms. When the leaflets are arranged in pairs without a terminal leaflet at the extremity of the rachis the leaf is described as abruptly pinnate or *paripinnate* (Fig. 5). The leaves of the Blackwood tree or Sisso (*Dalbergia*) exhibit another variation of the pinnate leaf. The leaflets are not paired, they are alternate and the apex of the rachis is crowned

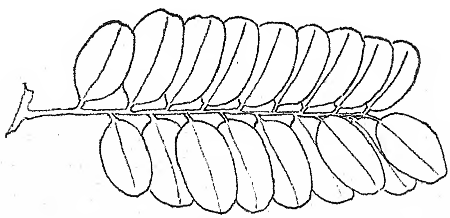
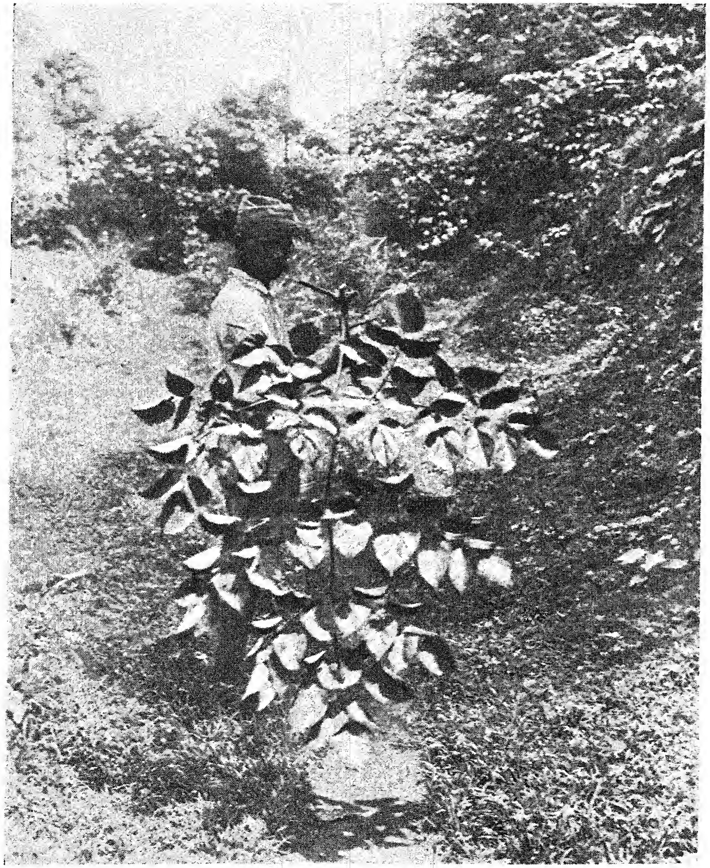


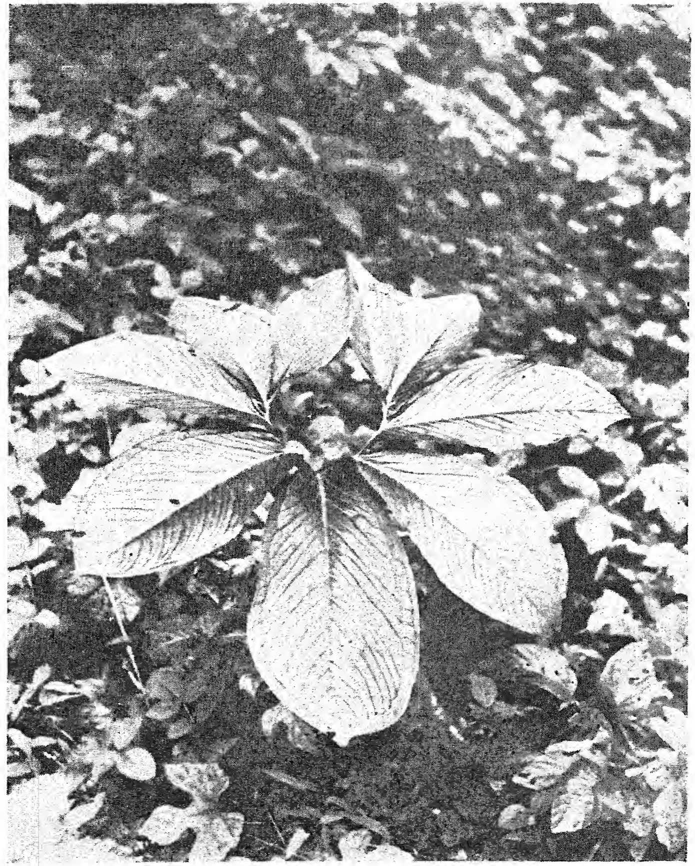
FIG. 6.

with a terminal leaflet. This exemplifies what is known as an odd-pinnate or *impari-pinnate* (Fig. 6) leaf.

A third variation of the pinnate leaf is illustrated by the Gold Mohur. The leaf is composed of a main stalk from which arise a



A COMPOUND LEAF. PINNATE OF *Oroxylum indicum*, VENT.



A SIMPLE LEAF; MUCH DIVIDED. *Sauromatum guttatum*.

series of smaller stalks which bear the leaflets. This form of leaf is *bipinnate* (Fig. 7) and the series of leaflets which constitute or form sub-divisions of the leaf are known as *pinnae*. Further divisions

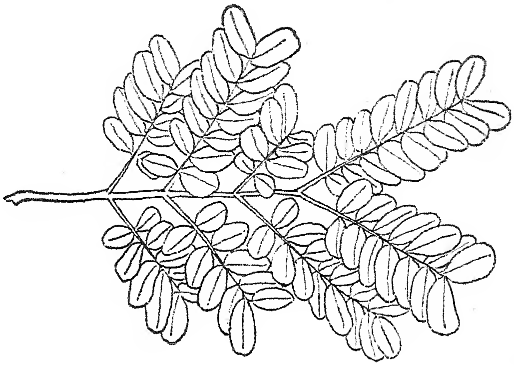


FIG. 7.

on these lines provide us with *tripinnate* variations and so on. These multipinnate variations are also known as *decompound* leaves. The leaves of the Drumstick (*Moringa pterygosperma*) tree afford an example.

The Flame of the Forest (*Butea frondosa*), whose beautiful orange blooms provide a gorgeous display of colour between the months of January and March, exhibits a different type of compound leaf. Here the pinnate or feather-like structure is absent. The leaf is composed of three large leaflets arranged at the end of the leaf-stalk. It is *trifoliolate* (Fig. 8). The number of leaflets which

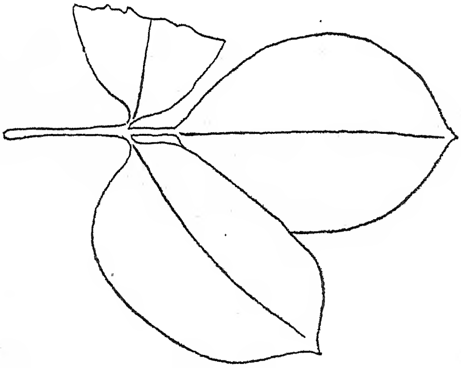


FIG. 8.

compose this type of compound leaf may vary. There may be 5, 6 and so on—when the leaflets are numerous—these leaves are called *multifoliolate*. The Silk-Cotton tree (*Bombax malabaricum*) is an example of a multifoliolate leaf.

Shapes of Leaves

Leaves present the same infinite variation of form as they do in their arrangement. These delicate organs are perhaps the most susceptible to the varying conditions of the plant's life. Their response to these conditions, to their varying requirements and purposes results in a diversity of form which is evident even in species of the same genus. These varying forms of leaves are designated by precise terms. As I have said before a knowledge of these terms is indispensible to the study of Botany. I illustrate some of the more common examples.

Fig. 9.

Fig. 10.

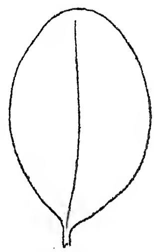


Fig. 11.

Linear: A grass blade illustrates this type (Fig. 9)—the leaf is several times longer than broad.

Oblong: The length is not more than twice or three times in excess of the breadth (Fig. 10).

Eliptic: Tapering at each end and broadest in the middle. The Alexandrian Laurel (*Calophyllum inophyllum*) is a good example (Fig. 11).

Fig. 12.

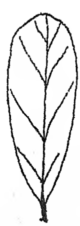


Fig. 13.

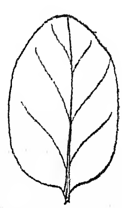


Fig. 14.

Lanceolate: Resembling the head of the lance. The leaves of the Asok (*Polyalthea longifolia*) can be taken as a type. (Fig. 12).

Oblanceolate: The reverse of lanceolate—the leaf is narrowest at its base (Fig. 13).

Ovate: Egg-shaped—the leaf of the Banyan illustrates this form (Fig. 14).

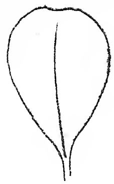


FIG. 15.

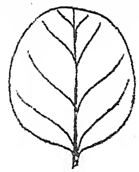


FIG. 16.

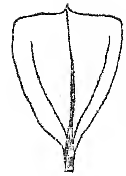


FIG. 17.

Obovate: The reverse of ovate—the broadest part is at the apex and not at the base (Fig. 15).

Rotund: Describes a nearly circular leaf (Fig. 16). The Water Lily (*Nelumbium*) is a type.

Cuneate: Wedge-shaped (Fig. 17).

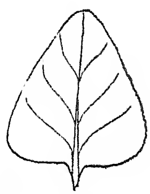


FIG. 18.

FIG. 19.

Deltoid: Similar to cuneate but the broad end of the wedge is at the base (Fig. 18).

Falcate: These leaves are not symmetrical but curved sideways. The *Eucalyptus* is a type (Fig. 19).

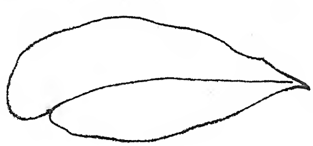


FIG. 20.

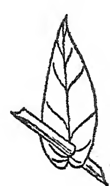


FIG. 21.

Oblique: A leaf not equally divided on either side of the midrib—one half being larger than the other. Example: many of the *Begonias* (Fig. 20).

The various parts of the leaf are again subject to considerable variation. The bases take various shapes, rounded or cordate as in the Banyan or *amplexicaul* when the base of the leaf surrounds the stem (Fig. 21).

The tip or apex of the leaf may be blunt (*obtuse*) or it may be tapering as in the Peepal (*Ficus religiosa*). In the latter instance it is described as *accuminate*. The mango leaf ends abruptly in a point—there is no prolongation of the apex as in the Peepal. It is described as *acute*. A leaf terminating in a depression is termed *notched*, one ending in a small spine-like point is called *mucronate* (L. *mucro*= point) (Fig. 22).

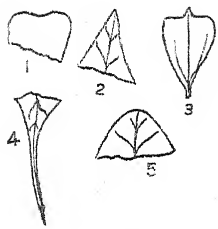


FIG. 22.

1. Notched; 2. Acute; 3. Mucronate; 4. Acuminate; 5. Obtuse.

The margins of the leaves are also subject to great variation. The Banyan leaf exhibits an entire margin. In the Asok, the leaf margins are wavy or *undulate*. In the Rose, the leaf edges are *serrate* or toothed like a saw. The blades of many grasses furnish us with examples. The minute serrations (in this case called *sirrulate*) on the margins of the blade are scarcely apparent till brought in contact with the bare skin when they readily make their presence felt. Large-toothed serrations are described as *dentate*, crescent-shaped ones are termed *crenate*, while those with small depressions as seen in the Lotus leaf are *sinuate*.

I have confined myself to the more distinctive types. A detailed account of the terminology descriptive of the various forms of leaves would fill many pages. The importance of these terms and their meanings becomes apparent in the interpretation of a scientific description of the leaves and other parts of the plant. The Banyan provides an example. The tree has a simple leaf with a short stout petiole—the form of the leaf is usually egg-shaped or ovate—its apex is blunt—i.e., *Obtuse*. The margin of the leaf is *entire*, i. e. it exhibits no irregularities or dentition such as seen in a Rose-leaf. The texture of the leaf is leathery or *coriaceous*. A technical description of the Banyan leaf would read as follows :—*Ficus bengalensis:* leaves coriaceous, ovate, margin entire, base rounded or cordate, apex obtuse, petiole short and stout.

The veins of a leaf are made up of vessels and fibres. Their function is to form a rigid framework for the leaf and to conduct liquids. The arrangement of veins is termed *venation*. Two distinct types of venation may be recognized—*Reticulate* or netted veins (Fig. 23) and *parallel* veins (Fig. 24). In the former the veins proceed from the midrib in the direction of the margins of the leaf and are connected by a network of fine veins or veinlets. The Banyan leaf is an illustration. In the latter type the veins run parallel to the midrib from the base to the apex of the leaf as in the Lilies and grasses, or they diverge

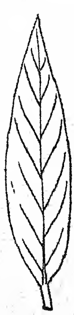


FIG. 23.

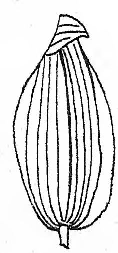


FIG. 24.

fan-wise from the base to the leaf margins as in some Palms, or they may be arranged in parallels across the leaf from the midrib to the margin as in the leaves of the Plantain. Parallel veins may or may not be visibly interconnected by smaller veins but these when visible do not form a network.

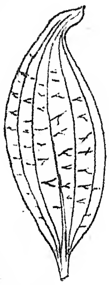


FIG. 26.

Reticulate venation, like parallel venation, presents considerable variation. The commonest type of reticulate venation is expressed by what is known as pinnate or feather-veined leaves. Here the lateral veins given off by the midrib extend directly towards the margin and are connected by a network of veinlets (Fig. 25). The leaf of the Castor Oil (*Ricinus communis*) illustrates a different form of reticulate venation. Instead of having a single midrib there are several veins or ribs which diverge from the point where the leaf-stalk joins the blade. This is known as *palmate* venation.

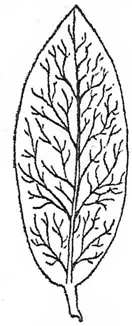


FIG. 25.

The leaf of the Cinnamon tree presents another variety of *ribbed* venation. The main veins or ribs do not diverge. They extend in almost parallel courses from the base to the apex of the leaf but, unlike parallel veined leaves, the veins are connected by a network of veinlets (Fig. 26).

The surfaces of leaves also call for attention. They vary considerably. Some are quite smooth, others are covered with hairs. The covering of hairs may be restricted to one surface or be present on both sides of the leaf or in particular parts. Smooth leaves devoid of hairs are called *glabrous* (L. *glaber*=smooth). Mango leaves provide an example. In the Banyan leaf the under-surface is covered with a mat of fine downy hairs—such leaves are described as *tomentose*. Leaves which are very hairy are termed *villous* (L. *villus*-wool). These hairs may be simple, short or long, sometimes with a bulbous base, or they may be branched in various ways. In some species they are star-shaped and receive the name *stellate*. Leaves whose margins are fringed with fine long hairs are called *ciliate*.

Hairs serve a particular purpose. They protect the leaf against excessive heat or cold which might cause the death of the plant. Hence we find them in evidence to a greater extent in plants which grow in countries where marked contrasts of climate prevail.

Other leaves are covered with waxy coatings. This is observed in particular amongst aquatic plants like the lotus. The waxy coating keeps the stomata or 'breathing pores' of the leaf from being choked. The leaf is thus able to transpire and give off the surplus water which it has absorbed.

Leaves, like other organs of the plant, exhibit as we have seen a great diversity of form. In many instances they are modified beyond recognition. Leaves may become spines, tendrils or pitchers. In the Holly and many of the Thistles the spiny projections from the leaf are formed by the prolongation and hardening of the

veins. In other species the whole leaf blade may become spiny. Spines must not be confounded with thorns. A thorn is a modified branch and like the branch it rises from the axil of the leaf not from the leaf itself.

Various parts of a leaf may be transformed to form a tendril, those organs, sensitive to contact, which I have already described. Their purpose is to enable the weak-stemmed plant to obtain a hold on any support with which it secures contact, and round which it twines. Such tendrils may be a prolongation of the leaf blade beyond the apex as in the leaves of the beautiful Monsoon Climber (*Gloriosa superba.*) At other times the entire leaf may serve the purpose of a tendril.

In the Carrion Pitcher Plant, specimens of which are often cultivated in gardens, the leaves are converted into a pitcher-like receptacle, while the leaf stalk or petiole frequently serves as tendril. In some Bladder Worts (*Utricularia*), the leaves take the form of small bladders. Each of these bladders is furnished with a valve which permits the ingress but not the egress of small water animals. Several species of these plants are found in tanks in India. In some aquatic plants, the petiole of the leaves are so modified as to form floats. The Hyacinth and the 'Singara' or Water-Chestnut (*Trapa natorus*) present examples. The petiole is dilated towards the centre where it encloses large air spaces. The whole leaf stalk is also spongy and filled with air cavities.

Although the foregoing paragraphs were mainly devoted to the description of the various forms of leaves, we must now resume the subject in order to refer to a few forms hitherto not noticed—curious and exceptional forms. The question before us is the adaptation of foliage leaves to their environment. While in the plant itself resides the principle of life, in the environment are found the conditions of life. Without the fulfilment of those conditions—i.e. without the regular supply of heat, air, water, inorganic substances and so on, to the living tissues—the plant would languish and die.

Let us consider a few of the modifications in structure which are the direct result of environment.

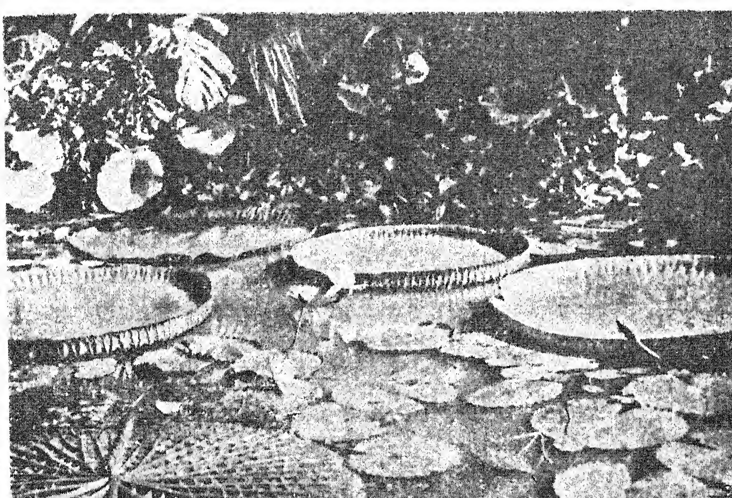
There are some plants which are *heterophyllous*, i.e. possess leaves of different shapes, as *Ficus heterophylla* and *Acacia heterophylla*. We are not in a position to offer or suggest any probable explanation for this phenomenon, but when we turn to water plants we can see the special usefulness of heterophyllous leaves. In the Bladder Wort, already mentioned, the leaves may take the form of filaments or be converted into bladders. Many other submerged aquatic plants found in tanks and streams have filamentous leaves, such as *Nias* and *Hydrilla*. In *Vallisneria*, another submerged plant, the leaves are flexible and ribbon-shaped. Such leaves are specially suited for an under-water life. If they were broad, they would offer too much resistance in flowing water and would therefore suffer. How well suited to their environment !—yielding readily to the current, and participating in its movements without injury. Plants that develop these filamentous leaves are usually found in flowing water. Some

aquatic plants develop *filiform*—thread-like leaves under the surface while those on the surface are entire.

The buoyancy of floating leaves is, in many instances, secured by special air-channels, which may be situated either in the blade or the leaf-stalk—more often in the latter as in the *Trapa* already referred to. This plant does not root itself to the mud but is carried hither and thither by wind and current like a rudderless ship.

In consequence of their aquatic life, water plants imbibe much more water than land plants and the transpiration (i.e. giving off of water) is proportionately greater. One sees in this fact the advantage of their broad, flat, floating leaves, which lying side by side on the surface of the water present so large a field for the sun's operations. Transpiration takes place through the *stomata* or pores which are situated on the upper surface of the leaves; in land plants they are generally restricted to the underside. When it is stated that a single leaf of a water-lily, of very ordinary size, may contain as many as eleven and a half million *stomata*, one realizes what liberal provision is made for the removal of superfluous moisture.

Still further to assist this end, the undersides of many floating leaves are coloured violet or crimson by a pigment called *anthocyanin* or *cyanophyll*. The pigment has the property of transforming the light of the sun into heat and thus increasing the warmth to the parts where transpiration is most active. This foliage painting is seen to perfection in our Lotus (*Nymphæa lotus*) and in the *Trapa*.



Courtesy *Standard Cyclopedia of Horticulture*

FLOATING LEAVES OF *Victoria regia* LOTUS AND *Nellumbium*.

The enormous leaves of the *Victoria regia*, the largest water-lily in the world, is another striking example (photo). This plant is famous

and familiar if not by sight at least by name. It was first discovered by Sir Robert Schomburgk during his explorations in South America on behalf of the Royal Geographical Society, in the year Queen Victoria ascended the throne (1837) and was named in her honour. This famous traveller records the event thus :—' It was on January 1, 1837, while contending with the difficulties which nature interposed in different forms to stem our progress up the River Berbice (lat. 4°30′ N., long. 52° W.), that we arrived at a part where the river expanded and formed a currentless basin. Some object on the southern extremity of this basin attracted my attention, and I was unable to form an idea what it could be ; but animating the crew to increase the rate of their paddling, we soon came opposite the object which had raised my curiosity and behold, a vegetable wonder ! All calamities were forgotten ; I was a botanist, and felt myself rewarded ! There were gigantic leaves, five to six feet across, flat, with a broad rim, light green above and vivid crimson below, floating upon the water ; while in character with the wonderful foliage I saw luxuriant flowers, each consisting of numerous petals, passing in alternate tints from pure white to rose and pink. The smooth water was covered with blossoms, and as I rowed from one to the other I always found something new to admire. . . . . Ascending the river, we found this plant frequently, and the higher we advanced the more gigantic did the specimens become. One leaf we measured was 6 ft. 5 in. in diameter, the rim five and a half inches high, and the flowers a foot and a quarter across '.

The undersurface of such floating leaves afford resting-places for numerous aquatic insects and snails. The eggs of the latter are frequently attached to such leaves. The upper surfaces furnish splendid rafts for many acquatic birds such as the Jaçana and others.

Large as are the leaves of the Victoria Lily, they are by no means the largest known. *Dracontium gigas*, a species of the Arum family discovered in Central America by Dr. Seeman in 1869, produces a leaf no less than 14 feet long. The stalk is beautifully mottled with purple and yellow and appears like a huge snake standing on its tail ! To come nearer home, another species of the same family, *Amorphorphallus titanum*, an inhabitant of Sumatra has also gigantic leaves which measure 18 ft. in circumference. The flower is proportionally large but this I shall describe when dealing with flowers. But there are greater leaves even than this. One of the Sago Palms bears fronds (leaves) which are upwards of forty feet in length and we believe that even larger ones have been met with. The Victoria Lily is however the largest known floating leaf and amply deserves the eulogies that have been lavished upon it.

Some fifty years ago an eminent German botanist named Hildebrandt gave an account of some interesting observations on the physiology of the floating leaves of *Marsilea quadrifolia*, a common flowerless plant found in our tanks. It has four leaflets arranged like the leaves of the Wood Sorrel (*Oxalis*). He discovered that when a plant of this species was submerged more or less deeply

under the surface, those leaves which were fully developed at the time of immersion remained unchanged, while those which were not so far advanced underwent a remarkable change. The petioles gradually lengthened in succession according to their position on the stem and, soon over-topping those which were already formed, reached the surface of the water. At first the four leaflets did not increase, but soon they began to enlarge and by the time the surface was reached they exceeded in size the ordinary leaves. The petioles of the ordinary leaves are rigid so that they stand erect out of the water. Those of the floating leaves are weak and flexible, as in water-lilies. This enables the leaf to maintain its position on the surface with the rise and fall of the water. The upper surface of the floating leaf is shiny and coated with wax, so that it retains no water on the surface. If submerged in deeper water, the petiole will elongate still further even to the extent of three feet—adaptation to environment.

Some aquatic leaves are beautifully perforated so as to avoid the danger of damage by currents.

We have seen how the leaves of aquatic plants obtain protection against the currents of water by special formation of the leaf-blade. Land plants require protection against strong currents of air and storms. It is very probable that the much divided leaves, both simple and compound, are divided and so shaped to offer as little resistance to the varying currents of air as possible. They thus escape rupture during heavy storms. In many cases tearing is prevented by a thickening of the upper layer of cells particularly on the leaf margins, where, of course, the strain is greatest. This is well illustrated in the leathery leaves of the India-rubber plant (*Ficus elastica*).

Leaves which assume a vertical position are specially exposed to the fury of the wind. The air currents usually travel parallel to the earth and in consequence strike against such leaves at right angles. Special adaptations are necessary to enable them to retain their upright position. In many of the grasses—the Common Rud (*Phragmites communis*) frequently cultivated in gardens, the leaf blades turn on the culms or *haulms* as they are sometimes called, like weather-cocks. The Reedmace (*Typha angustifolia*) and other allied species, a common reed in the beds and on the banks of rivers, has leaves that are spirally twisted, the whole leaf surface is thus never presented to the wind—an arrangement the advantage of which is sufficiently obvious. In other plants the protection from the wind is secured by the leaf being hollow. It is well known that a tube resists flexion more effectually than a solid body ; such tubular or *fistular* leaves will maintain an erect position in the roughest weather. The leaves of the Common Onion (*Allium cepa*) is a familar example of this type of leaf.

Leaves have been described as the 'lungs' of a plant. There are minute pores in the epidermis of a leaf which are exposed to the air. They are the minute 'breathing pores' or *stomata*. Under the microscope each stoma or mouth appears as an intercellular passage perforating the epidermis, bounded by two cells—the

Guard-cells. These guard-cells, as the name implies, protect the passage. They may contract and thus open the cell mouth wider or expand and close it to reduce evaporation. Generally, stomata are developed on the green parts of plants, but occasionally they are met with even on the coloured floral leaves. Hence they are naturally found in greater number on the leaves, as it is there that they are most required to facilitate the interchange of gases in the process of assimilation. In dorsiventral leaves the stomata generally, if not entirely, occur on the under-surface and average about 100 to the square millimetre, although in some plants their number may reach 700! Leaves like those of the Eucalyptus have stomata on both sides. Floating aquatic leaves have stomata only on the side exposed to the air. In the tissue directly under the stomata there are always small spaces termed *Respiratory cavities* which are in direct communication with the other air cavities extending throughout the leaf tissue. In plants which grow in an abundance of moisture, the air cavities are generally larger than in the case of plants growing in drier localities.

In contrast to the stomata, which as air-pores serve for the interchange of gases, a few plants have *water-stomata* or water-pores situated at the ends of the veins of the leaves. The pores discharge water or watery solutions. Calcium carbonate in solution is frequently excreted in this way sometimes forming scaly deposits on the margins of the leaves. Water-pores are more frequent in young leaves than in old ones. The guard-cells of water-pores usually lose their living contents early and thus leave the passage continually open. These stomata are always larger than air-stomata.

Submerged leaves of aquatic plants are devoid of air-stomata but water-stomata often occur.

Stomata regulate the evaporation. The guard-cells accomplish the opening and closing of the mouth through the changes in the turgidity of these cells or by the adjoining epidermal cells.

(*To be continued*)

MOSSES COLLECTED IN WAZIRISTAN BY MR. J. FERNANDEZ IN 1927

BY

H. N. DIXON, M.A., F.L.S.

The mosses collected by Mr. J. Fernandez were the first, so far as I am aware, collected in Waziristan. They comprised 66 numbers, many of the gatherings consisting of more than one species, so that there may be considered to have been about 100 different specimens. The total number of species was between 35 and 40.

The general character of the moss flora indicated is about what would be expected from the geographical position and conditions; the bulk of the species being those of moderate altitudes in the Western Himalayas, with a sprinkling of European and Western Asiatic types. There are 3 or 4 undescribed species; unfortunately the condition of the fruit when gathered leaves a certain degree of uncertainty as to the value of one or two of these. The new species of Splachnobryum, however, is a very marked and striking one, much the largest of the genus hitherto described; and the new species of Bryum is quite distinct, though its position in the genus is not altogether defined.

I give a list of localities mentioned in the paper with their respective altitudes.

Boya ...	... 3,440 ft.	Razani ...	... 5 000 ft.
Jandola	... 2,300 ,,	Sararogha	... 4,000 ,,
Miran Shah	... 3,100 ,,	Sarwekai	... 3,500 ,,
Razmak	... 6,300 ,,	Wana ...	... 4,500 ,,

In the following list I have followed for the most part the arrangement and nomenclature of Brotherus, in Engler & Prantl, Pflanzenfamilien, Musci, Ed. I.

Mr. Fernandez remarks that the general vernacular name for moss, as at Boya, is Kabom.

FISSIDENTACEÆ

Fissidens involutus Wils.—On soil, Miranshah; April 13, 1927 (4240b),

Fissidens grandifrons Brid.—On rocks, N. of fort, Razmak; May 10, 192', (4213a; 4275a). On mud, N. of camp, Razmak; May 7, 1927 (4316).

POTTIACEÆ

Hymenostomum amblyphyllum Dixon sp. nov.—Autoicum. Ab *H. tortile* (Schwægr.) differt foliis *latioribus*, inferioribus præcipue e basi dilatata ad (·5 mm) lata, late lanceolato-lingulata, omnibus *apice rotundato*, *nullo modo acuminata*, nunc *omnino obtuso*, *nunc costa egrediente brevissime obtuse apiculato*, Cellulæ superiores peropacæ, basilares perpellucidæ, unde pars basilaris a parte superiore valde demarcata. Margines folii late involuti. Costa *haud valida*, apud basin plerumque 40–50μ 'lata, raro 60μ, rufo-fusca.

Fructus immaturus tantum visus; setæ pulchre flavidæ.

Hab. On soil, Miranshah; April 13, 1927, (4277).

A species admittedly very near to *H. tortile*, but the leaves constantly obtuse or subobtuse at apex and with at the most an extremely inconspicuous, blunt apiculus, together with the comparatively narrow nerve, and the abrupt transition from the opaque upper cells to the hyaline basal ones, seem to warrant its being given specific rank; the wide leaves with very widely enrolled margins are also characters. The var. *brevifolium* Amann is described as having the leaves obtusely acuminate and the nerve not excurrent, and may come near the present plant; the nerve however is not described as being narrower than in the type form.

Eucladium verticillatum (L.) Bry. eur.—Razani : April 19, 1927 (3393).

Timmiella subintegra Dixon sp. nov.

A *T. Barbula* (Schwægr.) Limpr. differt tota planta *minore*, graciliore, foliis minoribus, nunc *integerrimis*, nunc apice *leniter indistincte denticulato* ; seta *tenuiore, breviore, vix* (1 *cm.*) *superante*, theca *minore*, 2·5–3 mm. longa, microstoma.

A *T. Giraldii* Broth. proxima differt foliis *sat cito madefactis*, theca ut videtur angustiore, paullo longiore.

Hab. Near top of conglomerate range, E. of fort, Jandola ; May 27, 1927 (4202, 4229, 4231, 4257). On mud, Miranshah ; April 14, 1927, (4221, *Ibidem*, April 13, 1927 (4240, 4265).

Although the characters distinguishing this species are slight, they appear to be constant, as they are maintained through all the different gatherings. The capsule agrees with *T. Barbula* in the persistent rudimentary annulus ; unfortunately in all the gatherings the fruit is very old, and I have been unable to ascertain the peristome characters, and also the inflorescence ; dissection of several fruiting plants has failed to show any antheridia or ♂ flowers. The constantly slender habit, the short, delicate, often flexuose seta, the small capsule, and especially the almost or quite entire leaves are quite marked distinctions. It is much more nearly allied to the Chinese *T. Giraldii* Broth., and I have been much tempted to refer it to that. Vegetatively it agrees almost exactly (the leaves in Giraldi's plant are not, as C. Mueller describes them, 'integerrima', but are often indistinctly denticulate exactly as here), with the one rather important difference that the leaves here moisten out rather rapidly, for the genus, while in Giraldi's plant they are remarkably refractory. Moreover the capsule in *T. Giraldii* is constantly wider, narrowly elliptic rather than cylindric, and very regularly 2 mm. long ; while here they are frequently up to 3 mm., and are constantly narrowly cylindric and slightly curved. The fruit in Giraldi's plant, however, are in better condition as to maturity, and one or two over-ripe ones are cylindric as here, so that it is just possible that the distinction of form might disappear if the fruit were compared at exactly the same stage of maturity. The fragments of peristome in the Waziristan plant are markedly papillose, while C. Mueller describes those of his plant as 'glabriusculi', a character which I have not verified.

On the whole I feel very little doubt that this is a quite distinct species from both *T. Barbula* and *T. Giraldii*.

Didymodon rufescens (Hook.) Broth.—On rocks, Razmak ; May 5, 1927 (4314) The most westerly record for this distinctively Himalayan species.

Didymodon tophaceus (Brid.) Jur.—On wet crumbling limestone rocks, Razani ; April 19, 1927 (3033).

Didymodon sp. or Barbula. A sterile plant belonging to one or other of these genera. Miranshah ; April 14, 1927 (4223).

Barbula indica Brid.—On rocks, Sararogha ; May 18, 1927 (4252). Probably its most westerly record in Asia.

Barbula Ehrenbergii (Lor.) Fleisch.—On moist crumbling rocks of soft limestone Razani ; April 19, 1927 (3528). On rocks, Wanna plain, Wanna ; June 16, 1927 (4364). On rock by Tank river, Sararogha ; May 18, 1927 (4374).

No. 3528, is of the highest interest, as it bears two capsules ; the fruit has not hitherto been found. The setæ are 1·5 cm. in length, dark purple, rather solid in texture and only slightly twisted when dry. The capsules are narrowly elliptic, 2mm. long without peristome, erect and symmetric, rather solid in texture ; the peristome is 8mm. long, dark red, strongly twisted (forming at least one full turn of a spiral) ; basal membrane none or very short ; teeth 32, *approximating closely in pairs*, the crura densely papillose, here and there united, or occasionally again divided, sometimes anastomosing ; teeth in the upper half anastomosing into a loosely coherent tube, from which the columella protrudes.

The peristome therefore is rather distinct, the teeth not being free and equidistant, as in Barbula, but distinctly paired, the halves sometimes conjoined, sometimes again subdivided, while sometimes the two crura, or again two

adjacent teeth may coalesce; while in the upper half the teeth are in a great measure anastomosing and coalesced, so that they form a loose tube. The lids had naturally fallen, and there is every reason to suppose the peristomes normal. This clearly removes the plant from Hyophila, from Didymodon, and from Trichostomum, under which genera it has been variously placed, and associates it closely with Barbula, under which Fleischer placed it, a position moreover which its near relation to *Barbula inflexa* (Dub.) seems to indicate.

It is quite possible, however, that the peristome character may justify a separate generic position, in which case the natural thing would be to raise the subgenus Hydrogonium C. M. to generic rank. Unfortunately however C. Mueller distinctly makes *Did. tophaceus* the type of this subgenus, whereas that species is clearly not congeneric with our plant. It seems best, anyhow, at present, to leave it in Barbula.

Crossidium sp.—On mud on hills, S. of Boya; April 8, 1927 (4216b). On rocks, S. of fort, Sarwekai; June 8, 1927 (4361).

This is either *C. squamigerum* or *C. griseum*; unfortunately the condition of the fruit—in the one case immature, in the other over-ripe—does not permit of the examination of the peristome.

Tortula atrovirens (Sm.) Lindb.—On soil in rock crevices, Boya; April 2, 1927 (4214b). On mud, conglomerate range E. of fort, Jandola; May 27, 1927 (4230, 4232). Mostly in poor fruit. Only recorded in Asia, apparently, from Caucasus and Syria.

Tortula inermis (Brid.) Mont. On mud on hills, S. of Boya; April 8, 1927 (4216a); On rocks, *ibidem* (4228, 4250a). On rocks in torrent bed, S.W. of fort, Sararogha; May 16, 1927 (4260). All in old fruit.

GRIMMIACEÆ

Grimmia tergestina Tomm.—On soil in rock crevices, Boya; April 2, 1927 (4214a). Sarwekai; June 8, 1927 (4237). On rocks, Boya; March 27, 1927 (4254). In rock crevices, Miranshah; April 14, 1927 (4369).

Grimmia pulvinata Sm.—On soil, Sararogha; May 21, 1927 (4210).

Grimmia orbicularis Bruch.—On mud, on high hills E. of fort, Miranshah; April 14, 1927 (4206, 4207). On rocks, S.E. of fort, Wanna; June 15, 1927 (4344). Mostly in poor fruit.

Grimmia trichophylla Grev.—E. of fort on high hill, Miranshah; April 14, 1927 (4208).

ORTHOTRICHACEÆ.

Drummondia Thomsoni Mitt.—On Tcherai trees (Quercus ilex, Linn.), Razmak; May 5, 1927 (3032b, 4309); Razani; April 20 & 21, 1927 (4243, 4263, 4266, 4320).

Varies considerably in length of leaf and degree of acumination of the point. Mostly in very old and very young fruit.

This and *Lindbergia Duthiei* were the only truly corticolous mosses collected, and were generally growing together.

SPLACHNACEÆ.

Splachnobryum procerrimum Dixon sp. nov.

Omnium specierum generis *maxima*; caules ad 6 cm. alti; parce divisi olivaceo-virides, molles. Folia admodum dimorpha, *nunc late lingulato-spathulata, apice latissime rotundata*; *nunc omnino orbicularia*, ad 1·5 mm. longa, concava, longe decurrentia, marginibus *erectis*, apud apicem leniter obtuse crenulatis; *costa plerumque ad dimidiam partem folii attingens*, tenuis, latiuscula, male delimitata, saepe furcata.

Cellulae laxæ, teneræ, supremæ, ovato-rhomboideæ, inde rhomboideo-hexagonæ, inferne pedetentim elongatæ, basilares perlaxæ.

Cetera ignota.

Hab. Encrusted with calcareous matter, on decomposing rocks on bank of stream, S.W. of camp, Sarwekai; June 7, 1927 (4163, type; 3984). Banks of the Watrah River, Ahmedabad District, Gujarat, India; December 1915: L.J. Sedgwick (1291).

A very fine and distinct new species. The Ahmedabad plant agrees exactly with the Waziristan one.

S. elatum Broth. from Martinique has stems to 3 cm. high; the leaves are elongate-oblong, shortly and obtusely acuminate, with nerve reaching to near apex.

FUNARIACEÆ

Funaria hygrometrica (L.) Sibth.—On rocks, Miranshah; April 13, 1927 (4429).

BRYACEÆ

Mniobryum carneum (L.) Limpr.—On rocks, Razmak; May 5, 1927 (4324).

Brachymenium acuminatum Harv.—♂. On rocks, Boya; April 8, 1927 (4250b). Leaves rather unusually comose, but probably from the fact that most of the stems bear terminal rosulate male flowers. Structurally the leaf agrees with that species.

Bryum. Several sterile and indeterminate species occurred; e.g. Nos. 4357 4372.

Bryum amentirameum Dixon sp. nov.

§ Doliolidium. Laxe cæspitosum; color propter vetustatem incertus; caules haud radiculosi, faciliter segregati, circa 1 cm. alti, innovationibus *numerosis microphyllis, amentaceis, subfiliformibus*, ad 1 cm. longis, prædití. Folia caulina valde parva, comalia majora, dense comata, concava, haud decurrentia, *late orbiculari-ovata*, breviter acute acuminata, marginibus erectis vel angustissime reflexis, integerrimis; costa rubra, angustiuscula, in apice desinens. Cellulæ minusculæ, anguste rhomboideæ, apud marginem seriebus 1–2 angustatæ, limbum angustissimum indistinctum instruentes.

Dioicum. Plantæ ♂ inter femineas intertextæ, filiformes, flores terminales magnos, sphæricos ipsæ atque innovationes iter iterumque repetitæ, gerentes 1 cm. vel ultra altæ.

Flos femineus parvus, foliis dense congestis concavibus imbricatis. Seta 1·25–1·5 cm. alta superne arcuata. Theca horizontalis vel nutans, haud pendula, *atro-fusca*; *e collo brevi defluente breviter oblonga*, ad orificium paullo angustata, *infra orem æque ac operculo atro-purpureo, nitida*; operculum conicum, acutum, sæpe acute apiculatum. Annulus latus, persistens. Exothecii cellulæ parvæ, irregulares, parietibus incrassatis. Peristomium infra orem longe insertum, *sat humile*; dentes externi intense purpurei, dense lamellati, lamellis extus paullo prominentibus, superne pallidi, *arcte papillosi*; endostomium inferne pallide aurantiacum, membrana circa dimidiam altitudinem dentis æquans; processus pallidi, papillosi, late hiantes, ciliis bene evolutis, breviter appendiculatis. Spori minimi, 8–12 μ lati.

Hab. On rocks (probably), N. of fort, Razmak; May 10, 1927 (4275).

The plants being rather dried up it is a little difficult to decide on its true position; the dark, blackish capsules and the vegetation indicate either Doliolidium or Erythrocarpa, and the capsule form is somewhat indeterminate (it must be admitted that the difference between these two groups—based entirely on the form of the capsule—is extremely elusive!). On the whole it seems best to place it in Doliolidium, near to *B. pangerangense* Fleisch., and others. The very marked, catkin-like, filiform innovations, with closely imbricate, almost julaceous, concave leaves, distinguish the present plant from all its near allies.

The male plants are rather distinct; the ♂ flower is terminal on a filiform stem; a single innovation arises below this, and itself produces a terminal ♂ flower—the following year, and this may be repeated; the flowers being rather large, globular and very dense, and the stem leaves very small, give a neat and rather striking appearance to the plant.

TIMMIACEÆ

Timmia bavarica Hessl.—Razmak; May 8, 1927 (1575). With young fruit.

Neckeraceæ

Cryptoleptodon flexuosus (Harv.) Ren. & Card.—On rocks, N. of fort, Razmak; May 7, 1927 (4330).

A very slender form. If the habitat is correctly given it is unusual, as the plant is nearly always found hanging from branches of trees.

Leskeaceæ

Lindbergia Duthiei Broth.—On Tcherai trees, Razmak; May 5, 1927 (3032a, 4294, 4296, 4302, 4305).

Mostly rather starved, but in fruit.

Amblystegiaceæ

Amblystegium serpens (L.) Bry. eur.—On soil, Razmak; May 7, 1927 (1739). Sterile.

Homomallium simlaënse (Mitt.) Broth.—On trees N. of fort, Razmak; May 7. 1927 (1709, 1716). With a few capsules.

Cratoneuron filicinum (L.) Loeske.—Razmak; May 5, 1927 (3131).

Cratoneuron decipiens (De Not.) Loeske.—In stream from the spring, N. of Razmak camp; May 10, 1927 (4213b). Hitherto not found east of Persia.

Hypnaceæ

Stereodon cupressiformis (L.) Brid.—On rocks N. of fort, Razmak; May 7, 1927 (4330b).

nov. var. vaucherianus Dixon.—Inter *S. cupressiformem* et *S. Vaucheri* ludens. Folii acumen longius tenuiusque quam in hoc, sed brevius quam in illo; cellulæ superiores paullo longiores quam in *S. Vaucheri*; alares minus numerosi quam in hac specie, atque paullo melius definitæ, cetero similes. Paraphyllia, ut videtur, desunt.

Hab. On rocks, Razmak; May 7, 1927 (1734). On tree, Razmak; May 5, 1927 (3166).

A curious plant, which seems almost mid-way between these two species. It has often the orange red colouring which is rather characteristic of *S. Vaucheri*, but unusual in *S. cupressiformis*.

Stereodon Vaucheri (Lesq.) Lindb.—On slope at base of trees and bushes, Razani; April 25, 1927 (3016, 4246).

Brachytheciaceæ

Brachythecium waziriense Dixon sp. nov.

§ Salebrosia. *Gracilis*; caules laxe repentes, *parce pinnatim ramosi*, olivaceo-virides, *haud nitidi*. Folia *sicca erecto-adpressa*, substricta, caulina usque ad 3 mm. longa, haud decurrentia, lanceolata, plicata, sensim e loco paullo supra basin angustata, stricte tenuissime acuminata, *marginibus plerumque angustissime recurvis*, hic illic planis, sæpius integris. Costa apud basin validiuscula, superne angusta, dimidiam partem folii vix superans. Cellulæ superiores angustissime rhomboideo-lineares, juxta basin *laxiores*, *basilares omnes latæ*, *medianæ breviter hexagono-rectangulares*, *alares quadratæ*, *majusculæ*, *numerosæ*, *subobscuræ*. Folia ramea simillima sed breviora, *apice fragili*, *sæpe abrupto*.

Cetera ignota.

Hab. On tree, Razmak; April 7, 1927 (1716, type.) Ibidem,; May 8, 1927 (1625).

Although sterile this is a rather marked little plant, with the habit and foliage of an extremely slender Homalothecium, but without the basal areolation of that genus. The lax basal cells are numerous, reaching to the nerve, quadrate at the angles, but irregular near the nerve; all rather obscure with chlorophyll. The leaves are widest just above the base, and taper very gradually from there to the apex.

A few stems only were gathered; so that it is not possible to tell the habit of growth satisfactorily, but it appears to be in any case not densely cæspitose.

TIGER TRACKS

BY

F. W. CHAMPION

Indian Forest Service

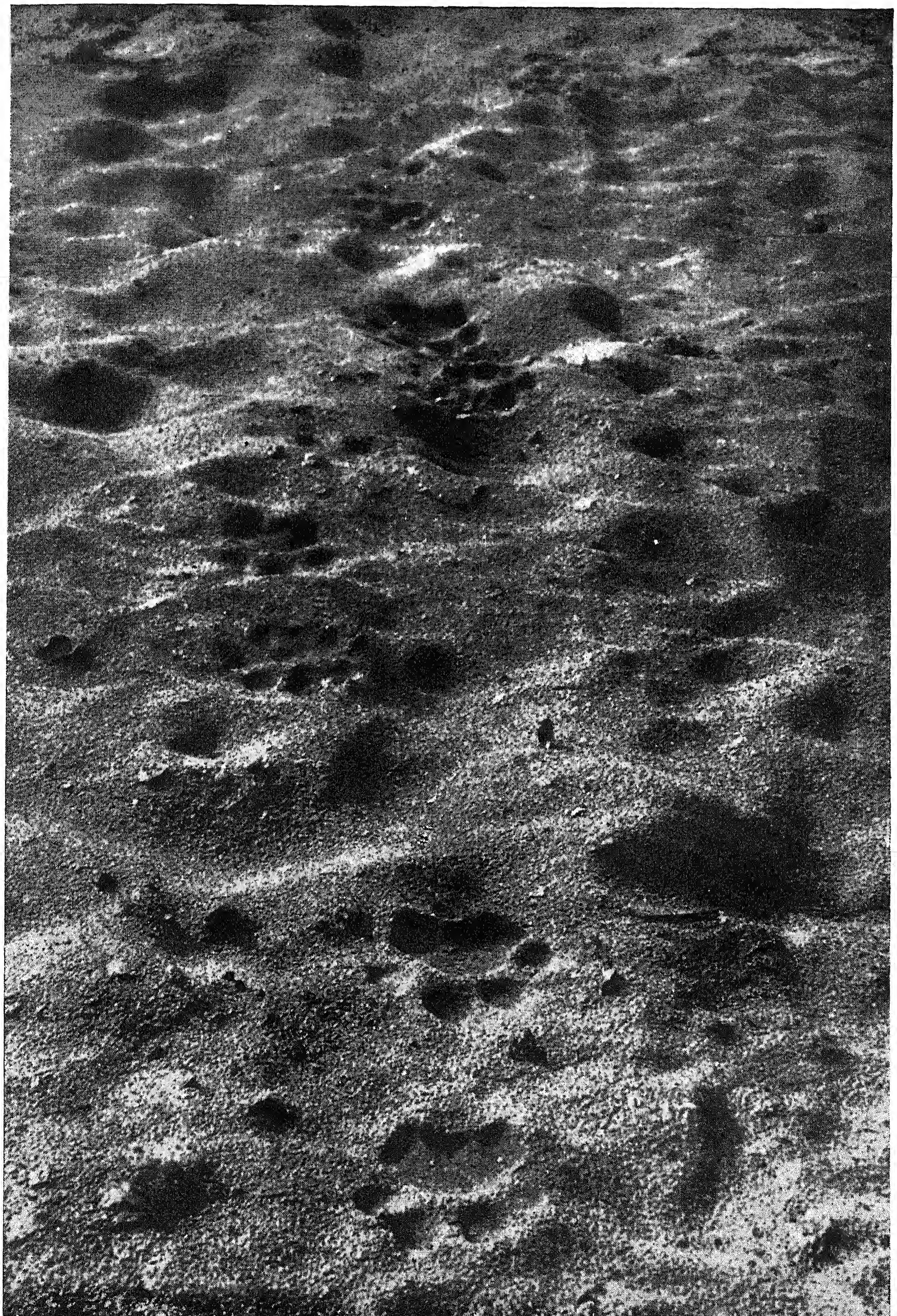
(*With four plates*)

I quote below a statement made in an old and at one time popular book on tiger-shooting :—

'When moving at either a slow crouch or a walk the hind-feet of a tiger usually exactly cover the spot vacated by the fore-feet, but crosswise—crosswise, because it stands to reason that an animal must have at least one leg on the ground simultaneously on *either* side to preserve its balance ; thus the right hind-foot takes the place vacated by the left fore-foot and then the same with the other two feet. In a feline, of course, this is a provision of nature to aid the animal in performing a *silent* stalk ; the eyes being over the fore-feet, the animal is able to pick the spots on which to place its fore-feet where they will make the least noise, that is to say, to avoid placing its fore-feet on a dry stick or leaf that might crack and so betray it ; there being no eyes in the rear portion of the animal to guide its hind-feet in a similar manner, it instinctively conveys the hind-foot to cover the exact spot that has been chosen for, occupied, and then vacated, by the fore-foot, thus avoiding the risk of accidently putting its hind-foot on a rolling stone or a dry stick which would make a noise. Thus a tiger usually leaves only a double trail as if it had only two feet instead of four, after the style of the trail left by a man walking, though the prints of the hind-feet will usually be found overlapping sightly to the rear of the prints of the fore-feet, perhaps half an inch or more. It is only when the tiger is standing or moving fast that the prints of all four feet of the animal will be seen on the ground. These facts serve to show the manner and pace at which the animal was travelling, and also the temper or state of mind of the animal at that time.'

The above-quoted paragraph—if one can master the involved English—gives the opinion of a man who had vast experience of the Indian jungles at a time when tigers were commoner than they are now and I hesitate to criticize statements made by a man who was obviously more qualified to speak than I am. Yet I have been giving the matter my careful attention for some years and I find that I cannot agree with either of the main points advanced, which, put briefly, are :—

(1) That a walking tiger usually puts his hind-feet exactly over the spots vacated by his fore-feet.



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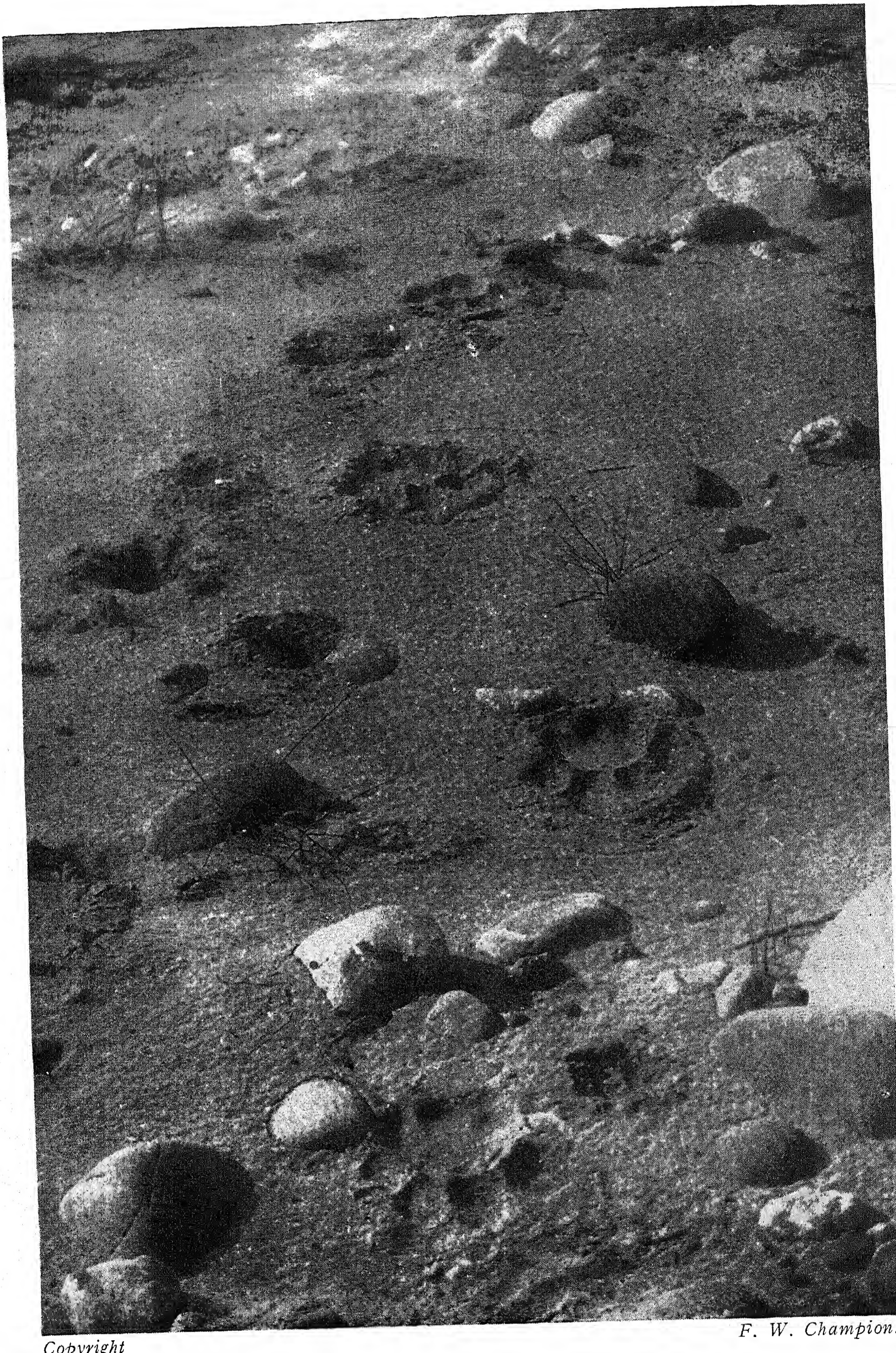
A double track on either side, with the hind-foot leading.



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A single track, that of the hind-foot, on either side.

(2) That he brings his feet forward crosswise.

As is well known, there is usually a considerable difference between the shape of the fore-feet and that of the hind-feet of a tiger, the fore-feet being larger, rounder, and more splayed out. The difference is much less marked in the case of a tigress and the fore-feet of a tigress often bear a great resemblance to the hind-feet of a tiger. These differences, although usually quite clear, are not by any means without their exceptions and I have known cases where, from the tracks, I should have been quite convinced that a tigress had passed, yet a flashlight photograph taken of the animal in question has proved what I thought was a tigress to have been, in reality, a tiger. I mention this point because, the more one studies natural history, the more one realizes how dangerous it is to make a definite and positive statement about any animal. After all animals vary among themselves, both in shape and habits, just as much as human beings, the variations among whom are infinite.

For practical purposes, however, we can take it for granted that, in the vast majority of cases, it is quite easy to pick out the fore-feet and the hind-feet among the tracks left by tigers and tigresses. On this assumption, I have found that, in the vast number of cases, the marks of all four feet are generally quite distinct—i.e., that a tiger usually leaves a double track on either side and that the tracks of the hind-feet generally lead. *Plate I* shows this type of track and it will be noticed that the track of the hind-foot is in front of that of the fore-foot in each case, the distance between the edge of the back pad of the hind-foot (leading) and the tip of the toes of the fore-foot (following) being some two or three inches.

At one time I used to think that almost all tigers walking at a normal pace on level ground left a track of this type, but I have since found that there are a number of exceptions. Indeed, I know one tiger—still alive I am glad to say—who habitually puts the hind-foot almost exactly on the spot vacated by the fore-foot and *Plate II* shows his track, which is a single one, where in almost every case—I have followed his tracks for miles—the hind-foot has been placed more or less over the spot vacated by the fore-foot. Yet I have known some shikaris to state positively that a tiger *never* leaves a single track, and others, such as the author of the above-quoted paragraph, who are quite positive that he nearly always does so!

I do not claim to be an authority on the subject, and I would ask others to ventilate their opinions in the Journal; but my experience has been that the ordinary tiger or tigress usually leaves a track showing an average of about two inches clear space between the tracks of the two feet, on either side, with the hind-foot leading in each case. I think the hind-foot track leads because the hind-leg of the tiger is longer than his fore-leg and thus has to be brought further forward to ease the action of his walk. The cases I have known where the tracks more or less coincided have usually been of big old tigers and it may possibly be that they have become stiff in the joints and thus bring the hind-leg less far forward than in the case of younger tigers.

Undoubtedly a lot depends upon what the tiger is doing at the particular moment he makes the track, and the same tiger seems to show most extraordinary variations, which would tend to suggest that his motion at night when on the prowl must be somewhat jerky. Yet when seen by moonlight this does not appear to be the case. I append herewith a series of observations, made in Lansdowne Forest Division on May 27, 1928, of a fairly large tiger which had passed during the night along a sandy path in a very open dry *rau* bed. 'T' represents touching (of which about 25 per cent were completely overlapping and thus showing only one track on each side—that of the hind foot) and the figures represent inches of clear space between the edges of the tracks of the two feet on either side, i.e., the distance between the back edge of the track of the (leading) hind-foot and the tip of the toes of the fore-foot :—

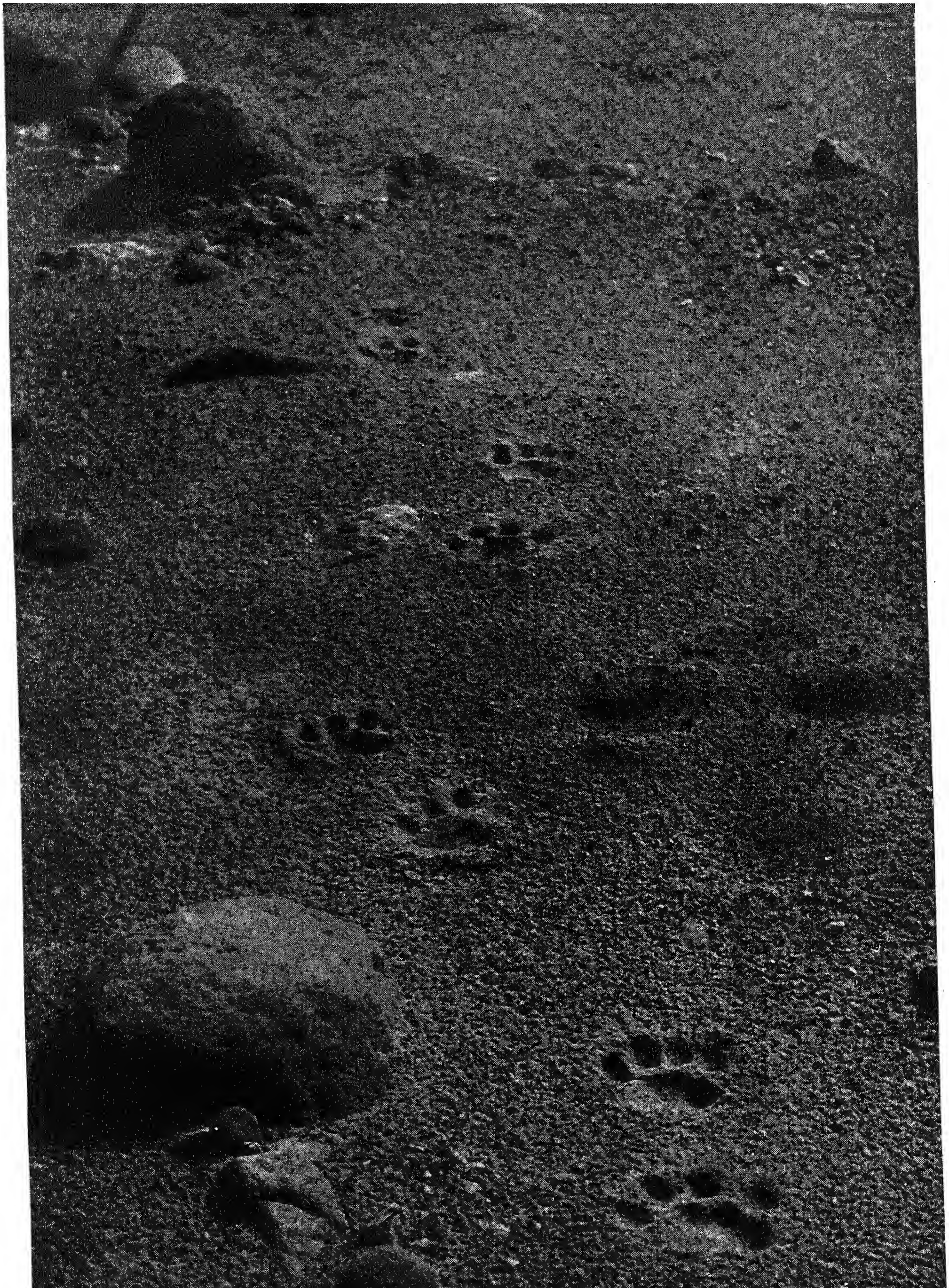
3 : 3 : 2 : 3 : 1½ : 2 : 1½ : 4 : 2 : 3 : 3½ : ½ : 1 : T : 2 : 1 : 2 : 2 : ½ : T :
½ : ½ : T : T : T : 1 : 2½ : T : T : T : 2 : T : 2 : 2 : 2 : T : T : 2 : T :
T : T : T : T : T : T : T : T : T : T : T : T : T : 4 : 3 : : 2½ : T : 2 :
3½ : 2 : 2 : T : T : 2 : 1 : 4½ : 2 : T : 1 : T : T : T : 1 : T : T : T : T : 1 :
T : T : T : T : T : T : T : T : T : T : 3½ : (18 T's running) : 1 : 2 : 2 : 3 :
2 : 2½ : 2 : 2½ : 3 : 3 : 1 : 2 : 2 : 2½ : 2 : 2½ : 2 : 1 : 1 : T : 1 : 1 : 1 : 3 :
3 : 1½ : 1 : 1½ : 1½ : 1½ : 1 : 1½ : 2 : 1 : 1 : T : 1 : 1 : 1 : 2 : 3 : 1 : 2 :
2 : 3 : 3 : 2 : 2 : 2 : T : ½ : ½ : 1 : 1 : 2 : 1 : T : T : T : 1 : 1 : 1 : 1½ :
3 : 2 : 2 : 2 : 2 : 4 : 3 : 4 : 3½ : 3 : 3 : 3 : 4 : 3 : 3 : 2 : 3 : 2½ : 3 : 1 :
1 : T : T : T : T : 2 : T : 3 : 2 : 3 : 5 : 4 : 4 : 3 : 4 : 4 : 4 : 3 : 5 :
6 : 6 : 6 : 6 : 5 : 6 : 6 : 6 : 6 : 5 : 5 : 6 : 4 : 6 : 3 : 3 : 3 : 4 : 6 : 4 :
5 : 4 : 3 : 1 : 2 : (65 T's running) : 1 : T : T : T : T : T : T : T : T :
T : T : T : 1½ : 1½ : ½ : 1½ : 1 : 2 : (40 T's running) : 1 : T : T : T :
T : T : T : 1 : (40 T's running).

(*Note*:—tracks which were not clear were not included in the above table).

A study of the above table shows that a very large number of the tracks touched. The actual figures are approximately 400 tracks, of which 234, or nearly 60 per cent touched. I did not record the number of tracks which were completely overlapping, but I would estimate it at 25 per cent of all the touching cases—that is 20 per cent of all the observations made. In cases where the tracks were separate the average distance of separation was 2½ inches. I would emphasise, however, that the tracks of this tiger touched more often than is usually the case.

I have records of other cases in which nearly all the tracks were separate, the average distance of separation being about 4½ inches, and of yet others where the vast majority touched. It will thus be seen that the variation is very great and that the statement quoted at the beginning of this article will not hold as a general rule.

I have not studied the question to any great extent with regard to the tracks left by leopards, but my general observations tend to show that the leopard, like the tiger, usually leaves a double track on each side with the hind-foot leading. Plate 3 represents a typical leopard-track.



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A typical leopard track.

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A tiger picture in which the two legs on the near side will be off the ground at the same time.

Now as regards the second statement—that a tiger usually brings his feet forward crosswise, as it stands to reason that an animal must have at least one leg on the ground simultaneously on either side in order to preserve its balance.

I would say at once that I believe this statement to be quite wrong. Why, birds can stand and even go to sleep on one leg, and there is no reason whatever why an animal in motion should not be able to keep his balance with only one leg on the ground at a time, a study of the photographs of galloping giraffes in Mr. Maxwell's fine book (*Stalking Big Game with a Camera in Equatorial Africa*) will clearly show that it is not necessary to have even one foot on the ground when moving rapidly. Also, for an animal to cross his legs in the way suggested seems to me to be an extraordinarily unnatural and uncomfortable method of progress, which is in no way compatible with the graceful movements of all the cat tribe. Plate 4 represents a tiger going on his ordinary nocturnal rounds. In this photograph the near hind-foot is right in the air and the near fore is just about to be lifted. It will certainly be off the ground before the hind-foot has reached its new spot in front of the mark left by the fore-foot, so that the two near-side legs will certainly be off the ground at the same time. There is also no suggestion whatever of any crossing of the legs. If anyone interested in this matter will examine some of the other photographs of tigers in motion, which have been included in my recent book *With a Camera in Tiger-land*, they will find no sign of crossing whatever and I cannot understand what led Mr. Hicks to make this (to me) astounding statement.

As I have already said, however, I do not claim to any great knowledge on the subject, and the United Provinces possess practically no expert Indian trackers—except the aborigines of Mirzapur, of whom I have no experience. I would therefore invite others whose experience of tracking may be greater than mine to put their views on paper and send them in to the Journal for publication.

INDIAN DRAGONFLIES

BY

LT.-COL. F. C. FRASER, I.M.S., F.E.S.

Part XXXII

(*With four plates*)

(*Continued from page 59 of Vol. XXXIII*)

Subfamily—EPALLAGINAE—(*continued*)

Genus—ALLOPHAEA gen. nov.

Euphaea Ramp. (pars), Ins. Nevrop. p. 228 (1842) ; Selys, Syn. Cal. p. 50 (1853) ; Id. Mon. Cal. p. 167 (1854) ; Walk. List Neur. Ins. B M. iv, p. 637 (1853) ; Will. Proc. U.S. Nat. Mus., vol. xxviii, p. 169 (1904).

Pseudophaea Kirby (pars), Cat. Odon. p. 109 (1890).

Characters as for the subfamily ; wings of male hyaline, saffronated broadly, hyaline and colourless in the female ; apices rather pointed ; hindwings not markedly broader than the fore and not broader than the same wing in the female ; petiolation very short, almost absent ; *Rii* not in contact with *R+M* ; node situated nearer base of wing than apex, about midway between base and pterostigma ; discoidal cell traversed once or twice short, about one-third the length of median space ; arc slightly bent ; sectors of arc arising from middle of arc and slightly separated at origin ; usually 3 cubital nervures to all wings ; about 4 intercalated sectors between *IA* and hinder border of wing, *IA* never forked ; 4 or more sectors between *IA* and *Cuii* ; origin of *Riii* usually very slightly distad of subnode or in continuation with it ; no basal incompleteantenodal nervure in subcostal space ; pterostigma present in all wings of both sexes, long, narrow.

Thorax robust but short ; legs as for subfamily ; abdomen extending beyond tips of wings in the male, sometimes markedly so, but of the same length in the female ; superior anal appendages homogeneous, simple, forcipate, longer than segment 10 ; the latter rounded or arched apicad and with a prominent keel or carinal spine on its middorsum ; vulvar scale robust, short, not extending to end of abdomen.

Genotype—*ochracea* Selys.

Distribution. Indo-malay and Indo-china, Assam and Burma.

Allophaea ochracea (Selys.) (1859).

Euphaea ochracea Selys, Bull. Acad. Belg. (2), vii, p. 443 (1859) ; Id. Ann. Mus. Civ. Genov. (2), x, pp. 56–57 (1891) ; Laid. Proc. Zool. Soc. Lond. (i), p. 87 (1902) ; Will. Proc. U.S. Nat. Mus., vol. xxviii, pp. 181–82 (1904) ; Mart. *Mission Pavie, Nevrop.* (sep), p. 15 (1904).

Pseudophaea ochracea Kirby, Cat. Odon. p. 109 (1890) ; Laid. Rec. Ind. Mus. vol. xiii, pp. 32–33 (1917).

Male. Abdomen 33–35 mm. Forewing 33–35 mm. Hindwing 30–33 mm. Head black unmarked, genæ, bases of mandibles and labrum glossy black, the rest matt black.

Prothorax matt black with the hinder border of posterior lobe narrowly, a small spot below it on each side, and a large semilunar lateral spot bright ochreous.

Thorax matt black marked with a series of 4 pairs of stripes on each side bright ochreous, the first pair antehumeral, confluent above and nearly so

below ; the second lying between the humeral and first lateral sutures, confluent above, and the posterior of the pair with the anterior of the third pair ; the third and fourth pairs lying between the lateral sutures and on metepimeron respectively, much broader and more diffuse than the two anterior pairs and, in fact, covering the greater part of the mesepimeron and metepimeron ; the trochanters and a small spot on each side in the antealar sinus ochreous.

Legs black unmarked.

Wings hyaline, both fore and hind broadly saffronated or amber-tinted, the fore for rather more than their basal halves, the hind as far as the pterostigma, which is black, a little oblique at its proximal end and covers about 6 cells ; discoidal cell of forewing traversed once, that of hindwing once or twice ; 3 cubital nervures in all wings ; nodal index,—about 30 antenodal nervures and 35 postnodals in forewings, and about 26 antenodal nervures and 35 postnodals in the hind. The hindwing slightly broader and shorter than the fore ; reticulation at apices very fine.

Abdomen black marked with ochreous as follows,—a diffuse lateral stripe extending from segment 1, where it is very broad, to segment 5 or 6, brighter basal rings on segments 3 to 5 or 6, and an apical ring on segment 1 ; the dorsal carina finely ochreous from segment 2 to 4 or 6. In subadults the general colouring of abdomen dark ochreous clouded with black ; in adults, segments 6 or 7 to the end black, unmarked.

Anal appendages black ; superiors slightly longer than segment 10, separated at base, parallel, compressed laterally and with blunt apices, which, as seen from above, curl slightly in towards one another ; inferiors very short, conical pointed.

Genitalia ; hamules projecting as two robust conical sharp teeth ; lobe black, large, scrotal-shaped.

Female. Abdomen 29-30 mm. Hindwing 28-29 mm.

Differs from the male by the much broader and more extensive yellow markings, by its more robust and stockier build, by its shorter abdomen and by its wings being only palely and diffusely saffronated in basal portions, the colouring being finally lost near the node in both fore- and hind-wings.

Head black marked with yellow as follows,—the whole of labium except extreme tips of lobes, the whole of labrum except the anterior border finely and a small median virgule springing from base, the mandibles, the cheeks broadly, a broad stripe across frons and a small oblique oval spot on each side of vertex with inner ends resting on the posterior ocelli.

Prothorax and thorax as for male but the markings more extensive and the whole of mesepimeron and metepimeron except their centres, which are clouded with black.

Legs brown, femora obscurely yellow on outer side and thinly pulverulent, as is also the underside of thorax and first two segments of abdomen.

Wings hyaline, coloured as detailed above ; pterostigma bright ochreous between black nervures, pointed inwardly, covering 7 to 8 nervures ; nodal index lower than in the male,—only about 20 antenodal nervures and 28 postnodals in forewings, about 20 antenodals and 25 postnodals in the hind ; discoidal cell as in male ; 3 or 4 cubital nervures in hindwings ; *Riii* arising a little distad of subnode in all wings.

Abdomen black marked with yellow as follows,—a broad lateral stripe extending from segment 1 to 7, constricted subapically and finely divided by the jugal suture near base of segments ; the middorsal carina finely from segment 1 to 5, obscurely so on 6 and 7, and often on 8, conspicuously so on segment 9 and less so on 10 ; a small rounded lateral spot on segment 8, a subquadrate one on each side of the apical two-thirds of 9, and the apical border of 10 narrowly. Anal appendages black, small, conical, pointed acutely.

Vulvar scale extending to end of segment 9, spotted with yellow.

Distribution. Assam, Burma, Malacca, Siam and Annam. The type in the Selysian collection comes from Mt. Ophir, Malacca. Khow Sai Dow Mt., 1,000 ft., Trong, Siam, Jan.-Feb. (Williamson) ; Gokteik, Upper Burma, June, coll. Col. F. Wall, I.M.S. ; Shillong, Assam, June, coll. T Bainbrigge Fletcher, and Cachar. August, coll. Mr. Antrim.

There is no difficulty in distinguishing this species, except from *brunnea*, by its hyaline wings, saffronated but without opaque areas. It has a wide distribution extending from Assam to furthest French Indo-china, and taken at altitudes from 1,000 to 5,000 ft. Larva unknown.

Allophaea brunnea (Selys) (1879).

Euphaea brunnea Selys, Bull. Acad. Belg. (2), xlvii, p. 374 (1879) ; Id. Ann. Mus. Civ. Genov. (2), x (xxx), p. 37 (1879).

Pseudophaea brunnea Kirby, Cat. Odon. p. 109 (1890) ; Mart. *Mission Pavie, Nevrop.* (sep.), p. 15 (1904) ; Laid. Rec. Ind. Mus., vol. xiii, p. 33 (1917)

Male. Abdomen 32-38 mm. Forewing 30-32 mm. Hindwing 28-31 mm. It is extremely doubtful whether this insect is distinct from the former ; Selys himself expresses such a doubt. In the 4th Additions to the Synopsis des Calopterygines he states that it is probably related to *ochracea* but is much larger. At the same time the measurements actually given by him are similar to those he gives for *ochracea* ! Again in his *Odonates des Birmanie* he states, apropos of the latter, that,—' It is possible that *E. brunnea* Selys (4th Add. au Syn. 64th) from Khasia Hills, which I described from a single male, may not be distinct from *ochracea*.'

I have not seen the type of *ochracea* but I have specimens of what probably is that insect from Siam, Burma and Assam and apart from size which varies considerably, even in the same locality, I can find no differences to separate them into two distinct species.

In addition to size, Selys gives another character, that of the colour of the wings which are said to be of a darker brown. Here again we find variability.

In a single specimen which I have from Shillong, Assam, collected by Mr. Bainbrigge Fletcher, the size is greater than in other specimens that I have seen from the same and other localities,—abdomen 38 mm. and hindwing 30 mm. and the saffronated parts of the wings are clouded with dark brown along the costa in the forewing and in the outer and posterior part in the hind. Another specimen from Kalaw, Burma, has the same dark colouring but its size is remarkably small. For the present and until more material is available, this question must remain open.

Distribution. Khasia Hills, Assam. Female unknown. Markings identical to those of *ochracea* which is also taken in the same hills. It must be noted that, at the time the two species were described, they had been reported from Malacca and Assam only, two widely separated areas, since which, *ochracea* has been found linking up the two in Burma.

Genus—PSEUDOPHAEA Kirby (1890)

Euphaea Ramb., Ins. Nevrop. p. 228 (1842),—Selys, Syn. Cal. p. 50 (1853),—Id. Mon. Cal. p. 167 (1854),—Walk. List. Neur. Ins. B. M. iv. p. 637 (1853),—Will. Proc U. S. Nat. Mus. vol. xxviii, p. 169 (1904).

Pseudophaea Kirby, Cat. Odon. p. 109 (1890),—Laid. Rec Ind. Mus. vol. xiii, p. 32 (1917).

Characters as for subfamily ; wings of male marked with opaque black, often metallic blue, green or purple ; hyaline in the female ; apices pointed in the forewing, inclining to be rounded in the hind, the hind markedly broader than the fore in the male and considerably broader than in the female ; petiolation absent or nearly so ; *Rii* not in contact with R + M ; node situated nearer base of wing than apex and slightly nearer base than pterostigma ; discoidal cell traversed once only, short, about one third as long as median space ; arc nearly straight ; sectors of arc separated at origin and arising from centre of arc ; usually only 2 cubital nervures in all wings ; 4 long and numerous short intercalated sectors between *IA* and hinder border of wing ; 2 long and 2 short intercalated sectors between *IA* and *Cuii* ; origin of *Riii* proximal of the subnode in all wings ; no basal incomplete antenodal nervures in subcostal space ; pterostigma present in all wings of both sexes, long and narrow.

Thorax robust, rather short ; legs as for subfamily ; abdomen extending well beyond apices of hindwings in the male, of the same length as abdomen in the female ; anal appendages very homogeneous, simple, forcipate, longer than segment 10, the latter with a marked middorsal keel or spine, its hinder border arched or ending in the dorsal spine ; vulvar scale robust, short, not extending beyond end of abdomen.

Genotype,—*variegata* Ramb.

Distribution. Ceylon, Western Ghats of India, Burmah, Indo-malay, Indo-china, Java, Sumatra, Borneo, Amboina and Philippines. (I have cited Western India, as *splendens* has been doubtfully reported from there.)

Pseudophaea splendens (Selys) (1853)

Euphaea splendens Selys, Syn. Cal. p. 52 (1853),—Id. Mon. Cal. p. 178 (1854),—Id. Bull. Acad. Belg. (2), xxxv, p. 485 (1873),—Walk. List. Neur. Ins. B. M. p. 638 (1853).

Pseudophaea splendens Kirby, Cat. Odon. p. 110 (1890),—Id. Journ. Linn. Soc. Lond. Zool. xxiv, p. 559 (1893),—Laid. Rec. Ind. Mus. vol. xiii. p. 32 (1917),—Id. Spolia Zeylanica, vol. xii, pp. 356–57 (1924).

Pseudophaea carissima Kirby, l.c. pl. xlii, fig. 4 (1893).

Male. Abdomen 35 to 41 mm. Forewing 31–36 mm. Hindwing 28–33 mm.

Head: labium blackish brown; labrum, cheeks and clypeus glossy black; rest of head deep velvety matt black.

Prothorax and thorax matt black, the latter with the first lateral suture and anterior border of metepimeron obscurely ochreous. In tenerals, the thoracic markings similar to those of the female.

Legs black, femora dark reddish-brown internally.

Wings opaque black, forewings with the base as far as midway to node hyaline but tinted with brown and with the nervures in the outer part of this area, bordered and clouded with opaque brownish black; apices of same wings paler from the level of proximal end of pterostigma; hindwings, except for a small basal area anterior to IA, opaque, to extreme apices, and darker than forewings on the upper surface, an area from base as far distad as halfway between node and apex of wings, brilliant metallic green or peacock blue according from which angle viewed, the outer border of this area running straight from costal to hinder border of wing but the basal limit not including that hyaline area already mentioned above; pterostigma black, very long, acutely pointed at its proximal end, a little broadened at its centre, covering about 12–14 cells; beneath hindwing, the metallic area has a deep glossy steely blue reflex. The membrane of wings markedly pleated; about 30 antenodal nervures in forewings and about 40 postnodals, about 22 antenodals and 30 postnodals in the hindwings; only 2 cubital nervures in all wings; discoidal cell traversed but once in all wings.

Abdomen black with an obscure lateral stripe of ochreous on segments 1 and 2.

Anal appendages black, spatulate, blunt at apex, hollowed out within, parallel, but the apices curled very slightly in. Seen from above triangular in outline, with broad base and pointed apex. Inferior appendages very short, conical, pointed.

Genitalia very similar to *ochracea* but the hamules a little less prominent and the lobe smaller and flatter.

Female. Abdomen 31–38 mm. Hindwing 29–37 mm.

Head: labium yellow with the tips and central portion of middle lobe black, the latter area pulverulent white; rest of head black as for male but with the bases of mandibles, cheeks, a small subrotundate spot just in front of each lateral ocellus, and the labrum citron yellow, the latter with its anterior border, base and a median basal triangular tongue black.

Prothorax with a large lateral boss on each side of middle lobe citron yellow.

Thorax with an antehumeral stripe not quite extending up to antealar sinus citron yellow, a small spot of the same colour on each half of the alar sinus. Laterally a thick stripe of yellow on the first lateral suture and the upper and anterior half of the metepimeron. In old specimens these lateral yellow markings and the underside of thorax pulverulent white.

Legs black, flexor surface of femora yellow and often pulverulent.

Wings hyaline, palely and evenly enfumed, brownish with a greenish tint, or in old specimens, the forewings clear and the hind only enfumed brown, with the apices for a little proximad of inner end of pterostigma dark brown. The extreme apices of forewings occasionally also enfumed. Neuration similar to that of male but occasionally only a single cubital nervure present; nodal index,—about 26–30 antenodal nervures and about 30, postnodals, 20–25 antenodals and 25 to 30 postnodals to hindwings; pterostigma dark brown between black nervures, covering about 10 cells.

Abdomen black marked with citron yellow as follows,—segment 1 broadly on the sides, segment 2 with a broadish lateral stripe sinuous in its apical half and dilated abruptly at its apical end, segments 2 to 4 with a narrow lateral stripe which is broken at the basal end so as to leave an isolated spot, segment 5 with only the basal spot.

Anal appendages half as long again as segment 10, conical and very acutely pointed at apex; vulvar scale robust, extending nearly to end of abdomen. (The male with a peculiar tuft of black stiff hairs springing from a small tubercle on each side of the ventral basal end of segment 9, the nature of which is unknown.)

Distribution: Confined to Ceylon, although Selys gives 'India' as one of its localities. If this is correct, it must be from the High Range Travancore, south of the Palghat Gap, where the Odonate fauna begins to take on a distinct Ceylon facies so far as at present known. I have specimens from Dyatalawa, 5,000 feet, August; Hatton, 4,000-5000 feet, May; Nalande, September and Dyraaba, September.

It is not uncommon on most of the montane streams of Ceylon and is to be found flitting slowly up and down stream or perching upon overhanging ferns above the water. When in flight, the male keeps the hindwings fully outspread, using them as planes and the forewings as propellers, so that the full beauty of the hind is displayed. It must be reckoned as one of the most beautiful insects found in Asia. The females are to be found in the neighbouring jungle, perched on prominent twigs from which they launch themselves on passing prey; rarely are they seen over their parent streams and I have never seen them in-cop or ovipositing.

Type in the Selysian collection, paratypes in most European collections and also in the Pusa, Calcutta and Bombay Museums.

Pseudophaea masoni (Selys) (1890).

Euphaea masoni Selys, Bull. Acad. Belg. (2), xlvii, p. 377 (1879),—Laid. Fascic. Malayenses (Zool), Part I, p. 194 (1903),—Mart. Mission Pavie, Nevrop. (Sep.), p. 15 (1904),—Will. Proc. U. S. Nat. Mus. xxviii, p. 182 (1904).

Pseudophaea masoni Kirby, Cat. Odon. p. 110, (1890),—Id. Ann. Mag. Nat. Hist. (6) xiv, p. 113 (1894).

Male. Abdomen 28-35 mm. Hindwing 24-30 mm. Forewing 26-31 mm.

Head: labium dark brown; labrum, cheeks, bases of mandibles and anteclypeus glossy black; rest of head matt velvety black and, in most specimens, an obscure reniform yellowish spot running obliquely out from each posterior ocellus.

Prothorax and thorax velvety black, the former unmarked, the latter, except in adult specimens (from Upper Burma), with the following yellowish brown markings all more or less obscure, especially in adults,—a narrow antehumeral line, a small spot on each half of alar sinus, a narrow humeral stripe, an equally narrow posthumeral complete in its upper half only; four parallel stripes on the sides, in two pairs, one on the mesepimeron and the other on the metepimeron.

Legs black.

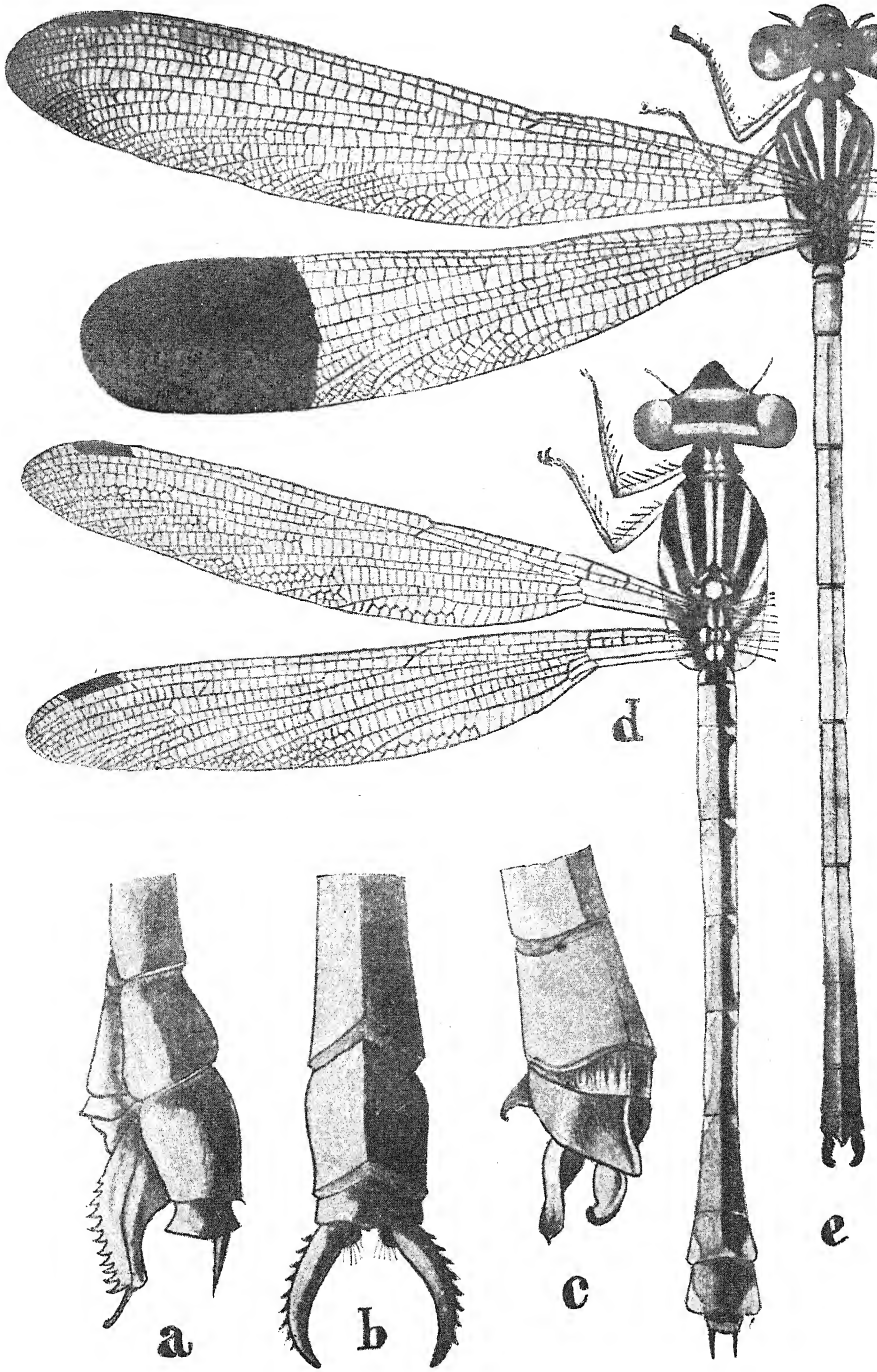
Wings opaque blackish brown, the hind with the extreme apex hyaline or occasionally hyaline as far as distal end of pterostigma and with the median space and base of subcostal space paler; forewings with the apex hyaline for a variable distance, as far as inner end of pterostigma or for 5 or more cells proximad of proximal end of pterostigma, the base of wing also hyaline but enfumed for rather more than halfway from base to node, rarely nearly as far as node, and in all cases, the subcostal space opaque as far as base, so that the hyaline area is traversed by a prominent black streak; pterostigma long, narrow, black, covers 8 to 11 cells; discoidal cells traversed once (entire in one wing of a Burmese specimen); normally 2 cubital nervures but occasionally 3; 25 to 30 antenodal nervures and 30 to 35 postnodals in forewings, 20 to 23 antenodals and 24 to 32 postnodals in the hind; the opaque areas of wings beneath steely metallic blue or bronzed.

Abdomen black, unmarked. Segment 10 with a very prominent carinal spine. Anal appendages black, superiors very similar to those of *splendens*, but more constricted at base and more expanded thereafter and with some minute spines at apex, which is curved in slightly. Inferiors very small, conical, ending in a fine point.

Genitalia very similar to *splendens*.

Female. Abdomen 33 mm. Hindwing 31 mm.

(This sex has not hitherto been described, I am indebted to the Paris Museum for the specimen from which the following description has been made.)



(*a*) Terminal abdominal segments of *Philoganga montana* Selys, showing saw-like ovipositor
(*b*) Terminal abdominal segments and anal appendages of *Philoganga montana* Selys, male, dorsal view.
(*c*) Terminal abdominal segments and anal appendages of *Indophæa fraseri* (Laid.), left latero-dorsal view showing spine on dorsum of 10th segment and left inferior appendage.
(*d*) *Philoganga montana* Selys, female.
(*e*) *Indophæa fraseri* (Laid.), male.

Differing entirely as usual from the male and very similar to the female of *splendens*.

Head : labium dirty brown tipped with black ; labrum citron yellow narrowly encircled with black and with a prominent median basal tongue of black, which nearly meets the anterior black border ; ante-and post-clypeus black ; cheeks, bases of mandibles, a very broad band traversing the frons and an elongate spot running obliquely outward from between the ocelli, all citron-yellow.

Prothorax black marked with yellow as follows,—a small subdorsal spot on each side of anterior lobe, a large lateral yellow boss on each side of middle lobe, the posterior margin of the posterior lobe narrowly and a small longitudinal medial spot above this lobe, and finally a large yellow boss on each side of the posterior lobe.

Thorax black marked with moderately narrow anthehumeral and humeral stripes, a fine posthumeral stripe broadly broken at its middle and lastly the whole of the sides and beneath, except for narrow black stripes outlining the lateral sutures.

Legs black, the proximal two thirds of hinder femora and the inner sides of middle femora yellow.

Wings long and narrow, uniformly enfumed greenish brown; pterostigma brown or dark ochreous finely framed in black, long and narrow ; *Riii* arising slightly proximad of the subnode, other details of venation as given for the male.

Abdomen black marked with greenish yellow as follows,—segment 1 largely yellow but with a basal dorsal patch of black and a lateral spot of the same colour, segment 2 with its middorsal carina narrowly yellow and with a broad longitudinal lateral stripe expanded apicad ; segment 3 similar but with the dorsal stripe tailing off and finally disappearing before the apical end, and with the lateral stripes expanded at both ends, segments 4 to 7 similar but without the dorsal marking and with the lateral gradually narrowing, segment 8 with a round spot on each side, 9 with a large subquadrate spot on each side, whilst 10 has a vestigial rounded spot only.

Anal appendages small, pointed, conical black. Vulvar scale yellow, not quite extending to end of abdomen.

Distribution. Naga Hills, Assam, in April ; Gok Teik, Upper Burma, in May and Tavoy District in April ; also below Maymyo, 2,500 ft, in June ; Daban in Annam, 600 ft, May ; Hoa Minh, Tonkin, and near Bangkok, Siam. The type in the Selysian collection comes from Tenasserim, Lower Burma. This species therefore has a very wide distribution extending from Assam to French Indo-China. Col. F. Wall, I.M.S., found it not uncommon near Maymyo, Upper Burma, and Mr. Elton Bott in Tavoy. It is subject to great variation in size like most other Pseudophaeas, but to a less extent, in its markings. It is one of the blackest dragonflies known and must be very conspicuous on the wing. The wing markings serve to distinguish it from others.

Pseudophaea bocki has been mentioned as from Burma by the late Rene Martin, but this is most certainly an error.

Genus INDOPHAEA gen. nov.

Characters of the subfamily ; hindwings of male with apices more or less broadly opaque black, nearly up to the node in one species ; forewings hyaline as also all wings of the female ; forewings with apices pointed, hindwings rounded, markedly so in some species and considerably shorter than the fore ; fore-and hind-wings of equal breadth, and wings of equal breadth in the sexes; petiolation distinct especially in the hindwings ; *Rii* not in contact with $R + M$; node situated much nearer base of wing than apex especially in forewings ; discoidal cell traversed, usually once, but occasionally entire and occasionally 3 times ; 2 to 5 cubital nervures, usually 3 ; *Riii* arising at, or slightly, or very widely distad of the subnode ; discoidal cell of forewing much shorter than that of hind and less than half the length of median space ; arc almost straight ; sectors of arc arising from middle of arc and widely separated at origin ; 3 or 4 intercalated sectors between *IA* and hinder margin of wing : *IA* never forked ; several short intercalated sectors between *IA* and *Cuii* ; no basal incomplete antenodal nervures in subcostal space ; pterostigma present in all wings, very long and very narrow.

Thorax robust; legs as for subfamily; abdomen cylindrical, very long and attenuated, usually much longer than hindwings (Markedly so in *fraseri* but of nearly the same length in *cardinalis*) but of the same length or shorter in the female; anal appendages very homogeneous, simple, forcipate; segment 10 pointed apicad and with a very robust dorsal keel; vulvar scale robust, not extending to end of abdomen.

Genotype,—*dispar* Ramb.

Distribution. Western Ghats of India, Indo-malay and Borneo.

Indophaea dispar (Rambur) (1842).

Euphaea dispar Ramb. Ins. Névrop. p. 230 (1842),—Selys, Syn. Cal. p. 51 (1853),—Id. Mon. Cal., p 169 (1854).—Id. Bull. Acad. Belg. (2) xxxvi, p. 614 (1873),—Walk. List. Neur. Ins. B. M iv, p. 640 (1853).

Pseudophaea dispar Kirby, Cat. Odon. p. 109 (1890),—Laid. Rec. Ind. Mus. vol. xiii, p. 32 (1917),—Id. ibid. vol. xix, pp. 25-27 (1920),—Fras. ibid, vol. xxiv, p. 9 (1922).—Id. ibid. vol. xxvi, pp. 479-480 (1924).

Male: Abdomen 39-47 mm. Hindwing 32-40 mm. Forewing 35-42 mm.

Head: labium dark reddish brown, paler at the borders of lateral lobes; labrum turquoise blue finely bordered with black and with a medio-basal tongue of black; bases of mandibles with a spot of turquoise blue; cheeks and epistome glossy black, rest of head matt black, unmarked.

Prothorax black with a large reddish ochreous boss on each side of middle lobe, a smaller reniform spot below it and the hinder border of posterior lobe the same colour.

Thorax black marked with bright reddish ochreous as follows,—ante-humeral and humeral stripes confluent as a broad loop above and narrowly separated below so as to nearly enclose a long oval spot of the ground colour, the rest, posterior to the humeral suture, which is finely black, bright reddish ochreous except for an oval spot of black between the humeral and first lateral sutures, and a small spot or beginnings of a stripe on the upper parts of the two lateral sutures. An elongate spot on each half of antealar sinus and the whole of underside of thorax bright ochreous.

Legs bright yellow except the extensor surface of femora and tibiæ which are dark reddish.

Wings hyaline palely enfumed with greenish brown; apices of forewings merely tipped with blackish brown; apices of hindwings broadly black to as far proximad of pterostigma as nearly halfway from apex to node; apex of this wing rounded and only about 3 mm. shorter than forewing but about 7 mm. shorter than abdomen; pterostigma black, covering about 12 cells; 3 cubital nervures to all wings; discoidal cell traversed once; *Riii* arising 1 to 2 cells distad of the subnode; about 24 antenodal nervures and about 40 postnodals to forewings, about 20 antenodals and about 38 postnodals to hindwings (Number differs widely according to size of insect). (Discoidal cell may also be freakishly traversed or entire, thus in one specimen the cells of the hindwings are traversed twice, whilst that of the right forewing is entire and that of the left traversed once). (Occasionally a specimen will be taken with the black apex of hindwing marked by a large hyaline window.)

Abdomen bright vermilion red, the segmental joints and the entire abdomen from the apical third of segment 6 to the end black. The apical end of segment 8 with a tuft of short black hairs on its ventral surface and about 8 long stiff black hairs beneath the basal end of segment 9; segment 10 with a very prominent dorsal keel.

Anal appendages very similar to those of *masoni*, black, ungulate, laterally compressed and hollowed out within, apices blunt and furnished with a few inconspicuous spines above. Inferior appendages very small conical, pointed.

Genitalia very similar to *masoni*, bright ochreous, the hamules finely bordered with black, lobe large, scrotal shaped, black.

Female. Abdomen 35-38 mm. Hindwing 34-39 mm.

Bearing a remarkable likeness to those of *splendens*, *masoni*, etc.

Head: labium dirty yellow; labrum and bases of mandibles turquoise blue, the former finely bordered with black and with a medio-basal tongue of black as in the male; anteclypeus black; postclypeus and a broad transverse band across the frons, as well as cheeks broadly bright ochre. A rounded spot of the same colour on the outer side of each hinder ocellus.

Prothorax and thorax marked similarly to the male, but yellow instead of bright reddish ochreous. The dorsal stripes are narrower, the black post-humeral spot is confluent with the black below, not entirely surrounded by brighter colour, the lateral vestigial black sutural lines are complete, although that on the first lateral suture is rather diffuse and often incomplete below. Legs as for male but more black.

Wings hyaline uniformly enfumed with greenish brown and the hind, in old specimens, with a moderately well-marked brownish black apex extending proximad slightly beyond inner end of pterostigma; venational details and pterostigma similar to male; *Riii* not quite one cell distad of the subnode; cubital nervures sometimes irregular, 2 to 4 in number and the discoidal cells sometimes traversed twice; pterostigma black, over about 12 cells; nodal index — $\frac{32\cdot18 | 17\text{–}34}{30\text{–}18 | 19\text{–}31}$.

Abdomen black marked with bright yellow or ochreous as follows,—1st segment almost entirely greenish yellow, segments 2 to 7 with a longitudinal stripe on either side, broad on 2, narrower on the rest and becoming interrupted on segments 6 and 7, the basal end expanded and cut off from the rest by the jugal suture; segment 8 with a small quadrate apical lateral spot, segment 9 with a larger similar spot, 10 unmarked.

(Markings subject to great variation,—in a specimen from South Kanara the markings are largely obsolete, especially on the abdomen, whilst those on the thorax are cut up into parallel lines of yellow by the black, even on the sides. In other specimens there is an additional small round spot on the inner side of each posterior ocellus and the hinder border of the posterior lobe of prothorax is bright yellow as in the male. Unlike *masoni* and *slendens*, there is no dorsal yellow marking on any of the abdominal segments.)

Anal appendages small conical pointed, black. Vulvar scale robust, marked with yellowish, not extending to end of abdomen.

Distribution. Confined to the Western Ghats of India from South Kanara and Coorg to the Nilgiris,—Malabar Wynaad. Easily distinguished from other species by the extent of black on apices of hindwings—and by its turquoise blue labrum and mandibles. The black area of wings has a steely blue reflex, as seen in some lights or dull coppery bronze in others. The female is distinguished from other species by its turquoise blue labrum. Like all Pseudophaeas there is a great disparity in size of specimens from various localities, those from lower altitudes usually being of smaller size than those from higher. It occurs from 3,500 ft. to 6,000 ft. breeding in streams. Usually the males, will be found perched on twigs some feet above the water, often at a great height, especially towards nightfall when they rise to the tops of neighbouring trees.

Females are not uncommon but must be sought for in the neighbouring jungle or ridings some short distance from the streams. They are very pugnacious and I have found them devouring tenerals of their own species! Rarely are they found in cop but I have a pair, which not even death, in the cyanide bottle, was able to part, an unique exhibit showing the double act of copulation.

Type in the Rambur collection, now I believe in the Selysian collection. Paratype in the British Museum, Pusa and Indian Museums, and in most private collections, to which I have been able to present specimens. It is on the wing from the end of May to September.

Indophaea cardinalis (Fras.) (1924).

Pseudophaea cardinalis Fras. Rec. Ind. Mus. vol. xxvi, pp. 512–13 (1924).

Male. Abdomen 41–45 mm. Forewing 39–42 mm. Hindwing 36–40 mm.

Head: Labium dirty yellow, brown at its middle; labrum bright ochreous narrowly bordered with reddish brown and an obscure mediobasal tongue of dark brown; anteclypeus dark blackish brown; postclypeus, bases of mandibles and cheeks bright ochreous; frons broadly reddish ochreous clouded with reddish brown at its middle and with a crenulate black basal line from which spring medial and lateral short black points; four small black points also projecting into base of postclypeus; rest of head black save for basal joints of antennæ and a small round point lying slightly to the outer and fore side of posterior ocellus on each side bright ochreous. Eyes dark reddish brown; frons coated with long black hairs.

Prothorax black with a large boss on each side of the middle lobe, the hinder border of the posterior lobe save at its middle, and the sides broadly bright ochreous.

Thorax bright reddish ochreous and black, markings very similar to those of *dispar*, thus,—antehumeral and humeral narrow ochreous stripes confluent as a loop above and nearly confluent below; the humeral suture narrowly outlined in black; laterally entirely ochreous save for a long oval spot of black between the humeral and first lateral sutures and the beginnings of narrow black lines on the upper parts of the lateral sutures; beneath ochreous.

Legs entirely reddish, the tarsi dark reddish brown, spines black.

Wings relatively broader than in *dispar* and marked very similarly. Forewings hyaline, faintly enfumed and with a greenish tinge, tinted with yellow at extreme base; hindwings with apical ends black as far proximad as 4 to 8 mm. from the node, and in some, quite the outer half of wing opaque black, this part dull coppery above, dull or steely bluish-black below; pterostigma long, covers 10-12 cells, black; *Riii* arising from half to one and a half cells distad of subnode or even in continuation of the subnode; discoidal cell entire in all wings of some specimens, or traversed once in the forewings, or twice or thrice in the hind, very variable; 2 cubital nervures in forewings, 2 to 4 in the hind; 20 to 24 antenodal nervures and 38 to 47 postnodals in forewing, about 18 to 20 antenodals and 38 to 40 postnodals in the hind.

Hindwing 2 to 3 mm. shorter than forewing and markedly rounded.

Abdomen bright vermilion red as far as the basal two-thirds of segment 6 from which point it is black. Segment 10 with a very pronounced carinal spine; segments 8 and 9 with tufts of long hairs ventrad.

Anal appendages similar to those of *dispar*, as also genitalia.

Female. Abdomen 36 mm. Hindwing 37 mm.

Head: labium black; labrum coloured similarly to the male; cheeks, bases of mandibles, a broad fascia traversing the frons but slightly interrupted at its middle, and a small oval spot on the outer foreside of the posterior ocellus bright ochreous; rest of head black.

Prothorax and thorax bright yellow marked with black as in the male but the lateral stripes on the sutures complete.

Legs blackish brown, the flexor surfaces of femora obscurely yellow.

Wings hyaline, uniformly enfumed with pale greenish brown, the hind more deeply than the fore and the apices slightly clouded with a darker brown; pterostigma black, narrow; 21 to 24 antenodal nervures and 31 to 33 postnodals to forewings, 18 antenodals and about 26 postnodals to the hind; discoidal cell traversed once in all wings; other venational points as for male.

Abdomen black marked with yellow, the sides of segments 1 to 3 broadly yellow; segments 4 to 7 with a longitudinal lateral stripe expanding basad and extending up towards dorsum so as to form incomplete basal rings; segments 8 and 9 with subquadrate apico-lateral spots, 10 unmarked.

Anal appendages short, conical, black. Vulvar scale very robust, yellowish, not extending to end of abdomen.

Distribution: Confined, so far as known, to the Palnai plateau, South India. Very few specimens have been collected of this very beautiful, and very local insect. To Mr. Bainbrigge Fletcher belongs the credit of first recognizing this species which, although it had long been in, at least, three collections, had been confused with *dispar*, even by such collectors as Dr. Ris and myself. This on account of its close resemblance to *dispar*, from which however it is easily distinguished when placed side by side. The much greater extent of the opaque area of the hindwing, the ochreous labrum and cheeks (turquoise blue and glossy black respectively in *dispar*), the close approximation of the length of wings to abdomen and the all-red legs are some of the differentiating characters. In addition to these, *cardinalis* has a large triangular tonguelike process springing from the apico-ventral border of the second abdominal segment, which is quite absent in *dispar*.

The female is easily distinguished by its ochreous labrum.

Type in the British Museum, paratypes in the Pusa, Ris, Morton and Fraser collections. The single female known is in the Fraser collection.

Found in numerous sholas, frequenting montane streams of the Palnai Hills from June to October.

Indophae fraseri (Laid.) (1920).

Pseudophaea fraseri Laid. Rec. Ind. Mus., vol. xxi, pp. 23–27 (1920),—Fras. ibid., vol. xxiv, pp. 8 and 9 (1922),—Id. ibid., vol. xxvi, p. 480 (1924).

Male. Abdomen 36–41 mm. Forewing 34–38 mm. Hindwing 29–35 mm.

Head: labium pale yellow; labrum pale azure blue with its anterior border broadly black, no medio-basal tongue of black; bases of mandibles azure blue, cheeks yellowish white; epistome glossy black; rest of head matt black with occasionally an obscure oval yellow spot on the outer side of each posterior ocellus; eyes dark brown.

Prothorax black with a large pale blue spot on each side of the middle lobe.

Thorax black with antehumeral and humeral stripes on dorsum, the former pale sky-blue in fine contrast to the black ground colour, narrow in its upper half, broadening rapidly in its lower; humeral stripe yellow turning to reddish ochre below, very fine throughout and occasionally broken into several sections. Laterally bright ochreous with reddish tinge posteriorly and marked with a large oval black spot between the humeral and first lateral suture and with the beginning of fine lateral stripes on the upper parts of the two lateral sutures; beneath bright reddish ochreous.

Legs as for *cardinalis* but a brighter red and the anterior pair dark reddish brown, almost black in some.

Wings very similar to *dispar* but the hind very markedly shorter than the fore and evenly rounded at the apices; forewings hyaline with the extreme apex tipped with brown; hindwing with the outer part opaque black with a coppery reflex above and a bluish violet below, this area slightly variable, usually extending from apex to about halfway to the node, less extensive in specimens taken at a low altitude, more extensive in those from a higher; discoidal cell traversed once in the forewings, twice or thrice in the hind; 3 cubital nervures in all wings; *Riii* arising 4 to 5 cells distad of the subnode; pterostigma black, long and narrow covers 8–12 cells; 18–20 antenodal nervures in forewing, and 32–36 postnodals, 15–18 antenodals and 27-30 postnodals in the hind.

Abdomen bright vermilion red to apical end of segment 6, which is clouded with black; segment 7 dark reddish brown to black at apical end: rest of abdomen black. Segment 10 with a prominent carinal spine.

Anal appendages black, very similar to those of *dispar* but with a distinct bend at about their middle; inferiors as for *dispar*.

Genitalia similar to *dispar* but the lobe smaller and bright red instead of matt black.

Female.—Abdomen 33–34 mm. Hindwing 31–33 mm.

Head: labium, labrum, mandibles and cheeks as for male; ante- and post-clypeus glossy black, the latter with a transversely oval blue spot at its centre; frons black, the creamy white of cheeks extending onto it on either side; rest of head black with a small oval greenish yellow spot on the outer side of each posterior ocellus.

Prothorax black with a large oval spot on each side of the middle lobe and the hinder border of the posterior lobe finely greenish yellow.

Thorax black on dorsum, bright yellow on the sides, marked as in the male but the line on the posterior suture rather better defined. In some specimens the antehumeral and humeral stripes are confluent above as a broad loop as in other species of the genus.

Legs yellow, femora blackish on extensor surface, tibiæ reddish.

Wings hyaline, palely enfumed, and in many specimens, with the apices of hindwings broadly dark brown to slightly proximal of the outer end of pterostigma in forewings and for a short distance proximal of the inner end in the hind; venational details as for male; discoidal cell traversed once in forewings, twice in the hind or less commonly once; 3 cubital nervures in all wings; pterostigma black, long and narrow, covering 9 to 12 cells; 17 to 18 antenodal nervures and 29–33 postnodals in forewings, 15 to 16 antenodals and 25 to 27 postnodals in the hind.

Abdomen black marked with bright greenish-yellow as follows,—segment 1 broadly so on the sides, the dorsal carina throughout except on segment 1 narrowly, but broadening out on segments 8 to 10, on the latter of which it forms a well-defined spot, the sides of segment 2 broadly, a longitudinal stripe on the sides of segments 3 to 6, broad on 3, becoming progressively finer on the succeeding segments until nearly lost or interrupted on segment 6, apical and basal spots on the sides of 7, a small apical lateral spot on 8 and a very large lateral spot on 9, whilst the sides of 10 are entirely greenish-yellow.

Anal appendages rather longer than segment 10, black, fine, tapering to a fine point. Vulvar scale robust, yellow, not extending to end of abdomen.

Distribution. North and South Kanara, Malabar, Coorg and the Nilgiri Wynaad. Found on the same rivers as *dispar* but at a lower elevation, thus in Malabar it occurs sparingly near sea-level. In Coorg and the Nilgiri and Malabar-Wynad it occurs up to 3,500 ft. from May to August.

Type in the Indian Museum, paratypes in Pusa and British Museums and in several private collections, Morton, Williamson, Laidlaw, Inglis and the authors. The males are not uncommonly seen resting with their wings well open as in genus *Lestes* and are usually found on low herbage along the banks of their parent streams. Females are not uncommon in the neighbouring jungle, settled on twigs at about 8 to 12 feet from the ground.

Subfamily PHILOGANGINAE Kennedy (1920).

Philoganginae Kennedy, Ohio Journ. Sci. vol. xxi, No. 1. p. 23. figs. 38-39 (1920).

Robust insects with general facies of both sexes resembling somewhat that of Epallagine females, but details of venation, etc., differing rather widely from that subfamily.

Fore-and hind-wings of similar shape and similar in both sexes, very long and very narrow, petiolated to nearly as far as level of arc ; node at about two-fifths of the wing length from base ; discoidal cell entire, short, about one-fifth to one-sixth the length of median space, its costal side slightly shorter than posterior, its distal end oblique ; *Ri* not in contact with *Rii* ; *Riii* arising at, or 1 to 2 cells distad of subnode ; arc slightly bent, situated at and in line with the distal primary antenodal nervure ; antenodal nervures moderately numerous, those in subcostal space more numerous than those in the costal and, except for the two primary antenodals, not coinciding with them ; 1 to 4 basal incomplete or subcostal antenodals, usually 2 or 3, and always a single subcostal antenodal between the two primaries ; no cubital nervures beyond the nervure *ac* in all wings, *ac* lying much nearer the distal primary antenodal or midway between the primaries ; petiolation marked, ending at a point opposite to or slightly proximad of *ac* ; *IA* straight, slightly concave or markedly convex, 1 to 2 rows of cells between it and posterior margin of wing, ending on wing margin opposite to or widely distad of node ; 1 to 2 well defined oblique nervures between *Rii* and *IRii* ; intercalated nervures between *Riv + v* and *I Riii*, *I Riii* and *Riii*, *Riii* and *Rii* ; pterostigma present in all wings of both sexes, long and narrow.

Head robust, Gomphine-shaped ; eyes rounded, tumid behind, rather widely separated from one another ; labium with middle lobe deeply cleft, ends of lobes acute ; labrum arched at free border.

Thorax very robust, short ; legs long and slim ; femora with 2 rows of very short, very closely-set, evenly-sized spines with more robust ones set at longer but even intervals ; tibial spines moderately numerous but rather short ; claw-hooks situated near ends of claws. (Tibiæ in one species with a fringe of hairs in addition to the spines.)

Abdomen robust, cylindrical, slightly dilated at anal end especially in the female, shorter than wings ; 10th segment flat on dorsum.

Superior anal appendages of male considerably longer than segment 10, sub-cylindrical, widely separated at base, apices curving in toward one another, blunt, minutely spined at outer border ; inferior appendages rudimentary. Superior anal appendages of female long and fine.

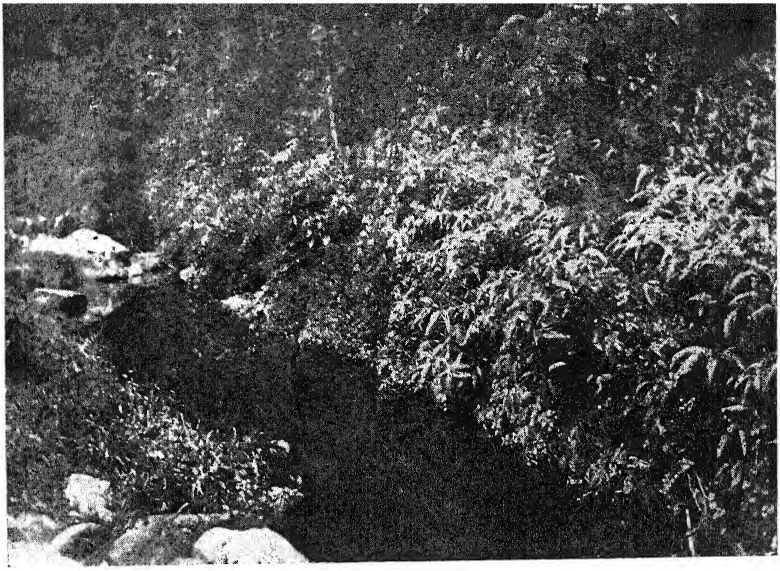
Genitalia bearing a close resemblance to that of the *Epallaginae*, especially the anterior hamules and lobe of penis, the former being foliate flattened quadrate processes inclined toward one another, the latter scrotal shaped and rather longer than in the Epallagines ; penis closely resembling that of *Amphipteryx*, its tentacles furnished with a fringe of spines at their apex, which is blunt. Vulvar scales very robust, extending well beyond end of abdomen and with the under border of scales coarsely serrate and evidently functionating as a saw for the insertion of ova into plant stems.

Distribution. Assam, Bengal, Burma, Indo-China and South China.

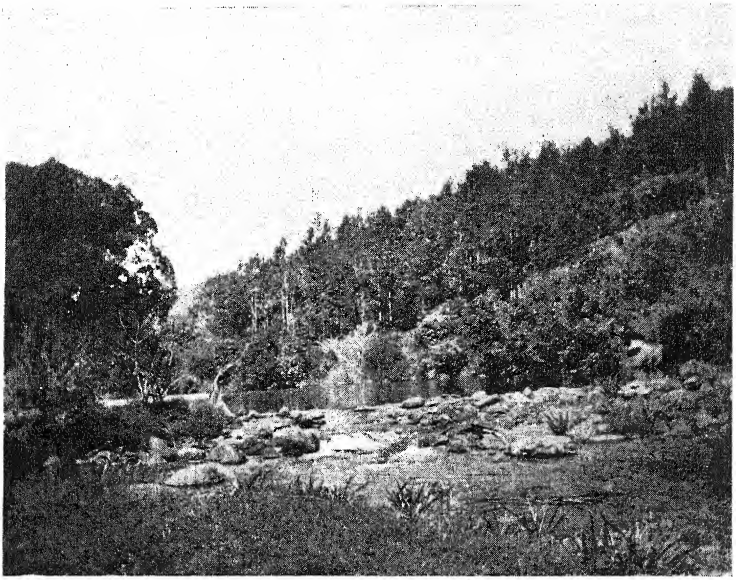
I have included the three known species of *Philoganga* under a separate monogeneric subfamily, as their true position is still doubtful, and must remain so until the larva is discovered. From the venation, the extremely long

Photographs by *T. Bainbrigge Fletcher.*

Two views of *Philoganga* pool, Shillong. Lower photograph a close-up view of upper. Specimens of *Philoganga montana* were taken resting, with wings outspread, on the bushes overhanging the pool, where the larvæ obviously breed.



A small stream at east end of valley in Shillong, Assam, where *Allophaea ochracea* (Selys) is found. *Disparoneura atkinsoni* Selys also frequents this stream.



Photographs by *T. Bainbrigge Fletcher.*

View of the Hatti River, North Coorg. *Indophaea fraseri* (Laid), is not uncommon along the banks of this river, whilst *Dysphaea ethela* Fras., frequents the rocks in midstream. Other species of dragon-fly found here are *Macromia indica, bellicosa, ida* and *atrata,* and several Gomphines.

petiolation and the fact that they rest with the wings extended flat as in the *Anisoptera*, it is clear that they are archaic insects, probably even more so than *Epiophlebia*. I place them for convenience after the *Epallaginae* because there is a strong resemblance in the genitalia, and the abdominal markings are typical of that subfamily. There however the resemblance ends, as the thoracic pattern, so characteristic of the *Epallaginae*, is quite different to that of *Philoganga* whilst the coinciding costal and subcostal antenodals and the short petiolation of the wings of the *Epallaginae* is quite different to what is found in *Philoganga*. The long petiolation of the wings, the long legs and the shape of the penis seems to show a relationship to *Amphipteryx*, an American genus.

Mr. Bainbrigge Fletcher has taken a number of *P. montana* along the banks of a montane stream in the Khasia Hills, so that it is evident that they breed in such spots. He has taken at least one teneral specimen here, but unfortunately failed to find its exuvia.

Genus **Philoganga** Kirby (1890).

Anisoneura Selys. Bull. Acad. Belg. (2), vii, p. 444 (1859) and Add. Syn. Cal. p. 10 (1859),—Id. 4th Add. Syn. Cal. p. 33 (1877).

Philoganga Kirby, Cat. Odon. p. 111 (1890);—Needham, Proc. U. S. Nat. Mus. vol. 26, p. 755, fig. 44 (1903),—Ris Suppl. Ent. No. 1, pp. 44-47 (1912),—Laid. Rec. Ind. Mus. vol. xiii, p. 33 (1917).

Characters and distribution as for the subfamily *Philoganginae*.

Three species only, *montana*, *vetusta* and *loringæ* of which the former is the geno-type. Only two species taken within Indian limits.

Philoganga montana (Selys) (1859).

Anisoneura montana Selys, Bull. Acad. Belg. (2), vii. p. 445 (1859),—Id. ibid, (2). xlvii, p. 379 (1879).—Kirby. Cat. Odon. p. 111. (1890).

Philoganga montana Kirby, l.c. (1890),—Laid. Rec. Ind. Mus. vol. xiii, p. 33 (1917),—Fras. Mem. Pusa, Ent. Ser. vol. viii, No. 8, p. 87, pl. ix, figs. 2-4 (1924).

Male. Abdomen 48 mm. Hindwing 45 mm.

Head : labium yellow, lobes tipped with black, bases of mandibles citron-yellow ; labrum glossy black ; rest of head matt black with two transverse narrow citron-yellow stripes, one traversing the cheeks and frons, the other running from eye to eye across occiput ; behind eyes yellow ; eyes brown.

Prothorax black with a longitudinal middorsal stripe bisected narrowly in the middle line of middle lobe and finely interrupted between the middle and posterior lobes.

Thorax black with some pruinescence beneath in adults, marked with greenish and citron-yellow as follows,—a narrow middorsal carinal stripe finely bisected by the middorsal black carina, a small spot on each half of the antealar sinus, a narrow complete humeral stripe, and laterally, two broad oblique stripes, the anterior borders of which are greenish, the first stripe on the mesepimeron, the second covering the entire metepimeron.

Legs black, femora broadly yellow on outer aspect, trochanters each with a large yellow spot ; tibiæ of male with a fringe of fine short hairs in addition to the spines.

Wings hyaline ; pterostigma blackish brown or paler brown, surmounts $2\frac{1}{2}$ to $4\frac{1}{2}$ cells ; 2 rows of cells posterior to *IA* this nervure being flat or slightly convex ; petiolation ends at *ac* or a little proximal to it in forewings ; 2-4 incomplete basal antenodals in forewings, usually 2, 2-3 in the hindwing ; nodal index variable ,— $\frac{26\text{–}12/18}{24\text{–}11/17}\Big|\frac{14/17\text{–}26}{14/17\text{–}24}$; $\frac{21\text{–}10/15}{17\text{–}10/17}\Big|\frac{10/17\text{–}19}{10/16\text{–}17}$.

Abdomen black marked with greenish yellow as follows,—segment 1 broadly yellow on the sides and with an apical annule broadly interrupted on the dorsum ; segment 2 with a lateral and ventral longitudinal stripe ; segments 3 to 7 with a latero-basal transverse spot and a lateral stripe, which on segments 3 and 4 has the apical end expanded, but on 5 to 7 tapers gradually away until much shortened on segment 7 ; segment 8 with a large triangular latero-apical spot, 9 with a similar but rounded spot, whilst 10 has the apical half yellow.

Anal appendages black ; superiors nearly twice as long as segment 10, subcylindrical, slender, curving gradually and evenly towards one another, apex

obtuse, the outer border near apex coarsely spined. Inferiors rudimentary, scarcely visible.

Genitalia as for subfamily.

Female. Abdomen 47 mm. Hindwing 52 mm.

Differs only from male in point of size and robust build. Wings occasionally palely yellow towards base ; nodal index similar but very variable ; only 1 or 2 incomplete basal antenodal nervures to all wings ; pterostigma as in male.

Anal appendages long tapering to a fine point, black. Segments 8 and 9 distinctly broadened, almost foliate laterally, segment 9 rather depressed.

Vulvar scale very robust, prolonged well beyond end of abdomen, coarsely serrate beneath.

Distribution. Assam and Bengal. Mr. T. Bainbrigge Fletcher has taken this species in moderate numbers during May and June, in two restricted localities bordering montane streams in Shillong. These were resting on bushes with their wings spread horizontally, in which position, from their shape and colouring, they looked very like Gomphines. Mr. Chas. Inglis has taken a male on the banks of a stream below Darjeeling. The type in the MacLachlan collection comes from Assam, and was probably collected by Mr. Atkinson in the same localities in Shillong.

Philoganga loringae Fras. (1927).

Philoganga loringae Fras. Rec. Ind. Mus. vol. xxix, pp. 79–81 (1927).

Male. Abdomen 41 mm. Hindwing 39 mm.

Head : labium dirty yellow ; labrum greenish yellow with a small medio-basal tongue of black ; bases of mandibles and cheeks citron yellow for as far up as level of antennæ ; rest of head matt black, pruinescent in parts ; eyes dark brown.

Prothorax black with a middorsal citron-yellow stripe broadening anteriorly and on posterior lobe.

Thorax black marked with citron-yellow as follows,—a moderately broad middorsal stripe finely bisected by the black middorsal carina, a narrow slightly sinuous antehumeral stripe ; laterally entirely yellow save for the second lateral suture which is broadly mapped out in black.

Legs long and slim, hind femora extending to middle of segment 2 ; anterior pair of femora black, the other two pairs dark ochreous ; tibiæ and tarsi black ; tibiæ not fringed with fine hairs as in *montana*.

Wings hyaline, petiolated to level of *ac* or slightly proximal in forewing ; palely and evenly enfumed ; pterostigma blackish brown covering $3\frac{1}{2}$ cells ; only a single row of cells posterior to *1A* ; only 1 cubital nervure to all wings ; *Cuii* slightly convex ; *1A* a little concave ; other details of venation as in *montana* except that the primary antenodals are not as distinct from the others and *Riii* is more distad in its origin, arising from 1 to $2\frac{1}{2}$ cells distad of the subnode ; nodal index, $\frac{22\text{–}13/17}{20\text{–}13/17}$; $\frac{13/19\text{–}21}{11/18\text{–}19}$.

Abdomen dark reddish brown ; segment 1 greenish yellow, segment 2 with a broad lateral bright yellow stripe narrowly bordered above with black, segment 3 with the black stripe continued but more diffuse and blotting out the ground colour on dorsum of segment, the ventral border dark ochreous, segments 4 to 10 similar but the dorsum entirely black, whilst segment 9 has a duplicate middorsal bright ochreous spot, and 10 two similar, but rounded spots on the dorsum.

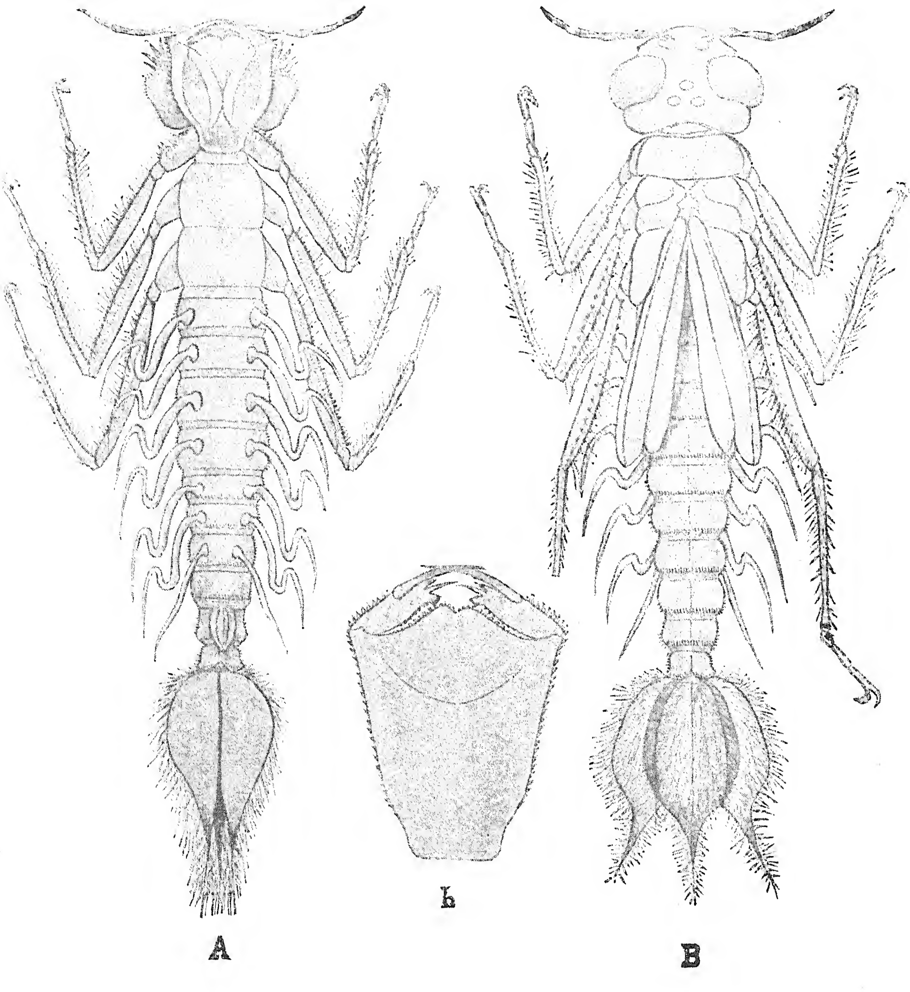
Anal appendages black, the superiors nearly twice the length of segment 10 curling gradually in to almost meet at tips, which are slightly dilated and end in obtuse points. On the outer side a few fine spines, much smaller than those seen in *montana*. In profile these appendages are seen to project straight back but the apices slightly upturned. Inferior appendages rudimentary as in *montana*.

Genitalia : Very similar to that of *montana*. Lobe depressed, moderately long, glossy black, resembling the flattened tumid body of a tick.

Female. Abdomen 42 mm. Hindwing 37 mm.

Very similar in markings to the male but a much larger and more robust insect.

Wings petiolated distinctly proximal to *ac* ; 2 basal incomplete antenodals in all wings, occasionally only 1 (2 to 3 in the male) ; a well defined oblique nervure between *Rii* and *IRii*, sometimes two of such (Usually not very



A. Ventral view of larva of *Pseudophæa splendens* (Selys) female. Note the seven pairs of abdominal gills which are really grappling-irons to anchor the insect to rocks in torrential streams.

B. Dorsal view of larva of *Indophæa fraseri* (Laid). Distinguished from the former by total absence of head spines.

b. Mask of larva of *Indophæa fraseri* (Laid).

evident in the male); pterostigma rather longer, covering $4\frac{1}{2}$ cells; nodal index, $\frac{22\text{-}13/17}{19\text{-}12/16}$; $\frac{13/19\text{-}20}{11/15\text{-}18}$.

Abdomen similar to male but sides of segments 9 and 10 broadly ochreous and the dorsal spots replaced by diffuse dark ochreous.

Anal appendages black at tips, brownish yellow from base, short, tapering to a point. Vulvar scale exactly similar to *montana*.

Distribution: Maymyo, Upper Burma. Four specimens, 3 males and a single female, the latter in cop. July 1925, collected by Col. F. Wall, I.M.S.

This very rare insect differs from *montana* by its much smaller size, by the labrum yellow instead of glossy black, by the markings of abdomen different and by the point of origin of *Riii*. It and *montana* are at once distinguished from *vetusta* Ris by having only a single row of cells posterior to *IA*. The female has the abdomen rather longer than the wings, the opposite condition being found in *montana*.

Epallagine larvæ

With the exception of *Anisopleura* and the *Pseudophaea* group we know little about the aquatic life histories of the *Epallaginæ*.

Anisopleura has already been described and figured in Part XXXI of this monograph; of the *Pseudophaea* group we know only the larvæ of *Pseudophaea splendens* Selys (Plate IV, fig. A), *Pseudophaea variegata* (Ramb.), *Indophaea dispar* (Ramb.), and *Indophaea fraseri* (Laid) (Plate IV, figs. B and *b*.)

The striking difference between these two group, viz., the total absence of abdominal gills in *Anisopleura* (and probably also in *Bayadera* and *Epallage*), and the presence of seven pairs of these organs in *Pseudophaea* and *Indophaea* tempts one to place these latter genera in a separate subfamily, the *Pseudophiinæ*. Possibly undue importance has been placed on these structures, which have been called, and said to function as, true respiratory organs. My own observations have led me to the conclusion that their real function is that of anchoring organs, for the larvæ are invariably found clinging to the flat surfaces of stones in the swiftest parts of streams, seemingly by the aid of these seven pairs of grappling hooks, the so-called abdominal gills. Were it not for these organs, they would be instantly swept down stream by the rush of waters as may easily be demonstrated by removing the gills and replacing the dismembered insect on a stone in a swift part of the current. The true legs of course are used for ordinary locomotive purposes, the pseudo legs or gills, having no powers in this respect.

The larvæ of *Pseudophaea splendens*, *Indophaea dispar* and *Indophaea fraseri* are all very similar, the two latter being indistinguishable, except by the locality which they inhabit; the former possessing a lateral beard-like group of robust spines external to and beneath the eyes. The gills are found on the first seven segments and are all S-shaped except the distal pair which are more or less weakly developed.

The caudal gills, as in *Anisopleura*, are triplicate, bladder-like structures, thickly coated with coarse hairs, one situated medially and dorsally, the others lying on each side of it, the apposed surfaces being flattened, the under-surfaces also flattened so as to lie flush with the surface on which the larva is resting. The mask is as shown, simple and without setæ.

(*To be continued.*)

MAHSEER (*BARBUS TOR*) IN BURMA AND THEIR HABITS

BY

A. MACDONALD

(*With two plates and a text-figure*)

Myitkyina, which is about 700 miles from Rangoon, is the rail-head of the Burma Railway and the head quarters of the most Northern Frontier District of Burma.

It is, besides, the headquarters of two Military Police Battalions. It has a very nice club, in which there is a fishing book kept, but unfortunately it only gives notes on the fishing in the higher reaches near Putao (Fort Hertz). Mine is the first note on the actual confluence and the water near Myitkyina.

These two great rivers, the Mali and the N'Mai Kha, come into confluence forming the Irrawadi, 29 miles north of Myitkyina. It can be reached by motor car, or at least to within a mile of the actual confluence, at a place called Thangpae, a Kachin village, from where a good path leads off. This is on the main road to Putao. The road is at present being rebridged in order that motor transport will be able to run up to Sumprabum, a Military post and sub-division about half-way to Putao, 90 miles from Myitkyina. When this road is completed, the Mali Kha will be much easier to fish up to a point (Tiang Kha) 58 miles from Myitkyina. The river is alongside the road most of the way, and about 200 feet below.

The river up to this point (Tiang Kha) has some excellent rapids and will stand any quantity of fishing.

During the three years I was resident in this district, I know of no one giving this water a trial. Col. Summerville went up to the higher reaches in 1924, a distance of 220 miles, leaving this wonderful water. His best fish was 52 pounds; the best that season was 63½ pounds also caught in the higher reaches. In 1925 and 1926 there was no fishing done by the residents of Myitkyina, to my knowledge, though the river here is all good. Five miles below Myitkyina is where the record fish for Burma was caught, 92 pounds.

I was myself never able to get up to Myitkyina except for a week in May 1926, when the river was discoloured and the snow water down; I did no good. This season and 1927, there have been several keen fishermen on the water, in fact the whole station was keen, even the ladies! The confluence received attention on week-ends, being now conveniently reached by car. Nothing larger than 40 pounds was taken.

This season, these waters also had visitors. Two rods went to Seniku for a week, another celebrated spot in this district, where a

fishing log book is kept, and large fish have been taken, 29 miles from Myitkyina up the N'Mai Kha, where two rivers come into confluence, then run a couple of miles and join the N'Mai Kha.

It is at the confluence, of the Mali, and N'Mai I think, that Rivett Carnac's fine fish of 119 pounds will be beaten. I have seen fish rising here that were 18 inches across the back if an inch, so judge for yourself what their weight might be ?

The local people, Kachins, are of no value to you as they are a lazy crowd, so all arrangements should be made at Myitkyina.

The Sub-Divisional Officer, who is generally a sportsman and very obliging, will do all to assist you in obtaining a boat; which is necessary, and mule or cart transport for your kit. Mule transport is most satisfactory, and enables one, if necessary, to leave the road, and camp alongside the river. Cars are not available on hire but there are a number of merchants (Chinamen and Indians), who own cars and generally lend them if approached nicely.

Supplies should all be taken up with you as the Kachin is reluctant to sell his fowls, keeping them for *Nat* (Spirit) offerings. A shot gun and rifle should also be part of one's kit as there is a quantity of small game, and an occasional tiger which might be shot. I shot snipe both Fantail and Pintail in May. R. T. also got a woodcock.

There is a nasty little fly which bites and settles on you in swarms here. There are in fact, hundreds of different varieties of biting bugs from the large green-eyed horse fly to the little fellow, besides the blood blister fly, and then of course you get the mosquito and sand fly at night. It would be as well to take up Citronella in large quantities for both yourself and your following. Illness in any quantity, up here, would completely ruin your trip. The usual medicine chest should also accompany one, as the local people frequently come round asking for treatment. A gramophone also is much appreciated at night, and the village turn out *en masse* from the old grey-haired ladies to the youngest babes. Jack Smith is much appreciated.

Boatmen are obtainable with boats at Myitkyina and take two days to get up to Thangpae, but I would suggest that the boat be joined at Chingkran Zup, a bungalow at the twenty-second mile.

From here up all the water is good, and two miles above you come to the 'Rocks' which must hold enormous fish. I did not work this water thoroughly as I intended doing it on my return ; but had to cut my fishing trip short. It is a barrier of rock across the river, breaking the water up into five channels at the tail of a fast rapid. Most of this water can be got at by boat.

The fishing from Ching Kran Zup, 22 miles from Myitkyina to Tiang Kha, a distance of 37 miles is all good, though some of the best looking water proved most disappointing.

The actual confluence is unparalleled from the results we had. I got on to this water on April 12th and joined R.T. who had been up about a fortnight before I arrived. We took, between us, up to May 8th, 66 Mahseer weighing 1187½ pounds, an average of 18 pounds. Of these fish all but 180 pounds were caught at the confluence.

The higher reaches of the Mali Kha were not thoroughly tried out, as we had no boats, causing many of the best places to be left.

The five largest fish we took were 75, 55, 50, 45, and 44 pounds, losing many others. One fish I had on for just under two hours. Hooked at the favourite spot of the monsters, he took me down stream in short determined rushes, about six hundred yards. I followed in a boat, when the spring of my Silex reel broke causing me to hold on to the drum to prevent an over-run. I fought him like this for an hour, till R.T. joined me. We then managed to effect a change of the spring from his reel to mine during a spell of sulking.

He worked us down to the head of the main Zup (confluence) into the 'V' where it was impossible to follow in a boat; the reel again gave trouble, the drum jammed as he made off, causing the trace to give.

What this fish weighed is left to the imagination. At the end of nearly two hours fighting and a heavy strain the whole time, he was complete master of the situation; I could do nothing with him.

The 75 pounder, though game and going strong the whole time, I killed in forty minutes, hooked lightly through the eye.

R.T. lost a fish in exactly the same place. He got into his fish nearly a mile above the actual Zup and was brought down after crossing the river seven times with only short spells of sulking. He lost his fish after a two hour's fight.

A description of the confluence may here be of interest. These two rivers run in as Rapids forming a large deep pool which is the home of the grandmothers; it is over a hundred feet deep in places, with outcrops of rock dotted about. The Mali Kha is a hundred yards wide and the tail of the rapid where it enters the pool has a number of large 'Rock Islands' breaking up the water into a number of narrow channels. The water of this river is not as clear but warmer than that of the N'Mai. The N'Mai Kha is much the faster and larger of the two, but its crystal clear waters, which are always very cold, proved most disappointing, though otherwise the better-looking water of the two.

What has been most interesting to me, and I hope will be to readers also, is that there are at least six distinct varieties of mahseer to be taken in these waters.

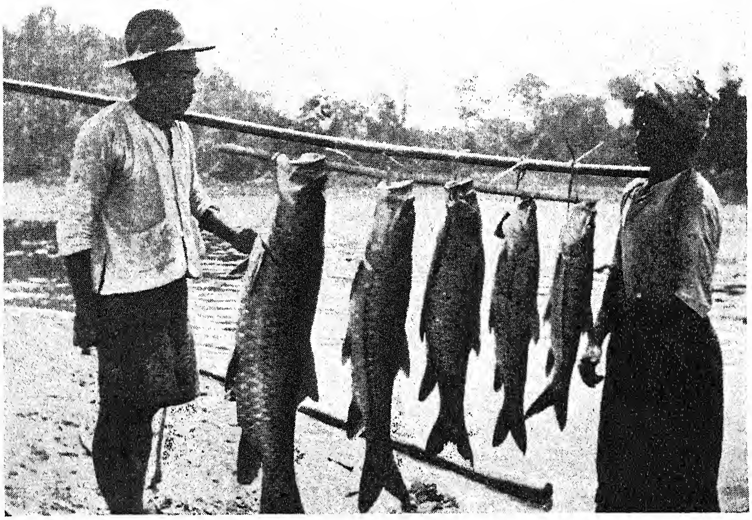
I have endeavoured to describe their colourings and general differences which though humble, will serve the purpose of identification by fishermen.

I kept the fish alive in the water beside me while I undertook this difficult task. They all fit the description of Dr. Day's *Barbus tor* in the main points i.e. Barbels, 'Fin' rays, and lateral line, etc. (see photographs).

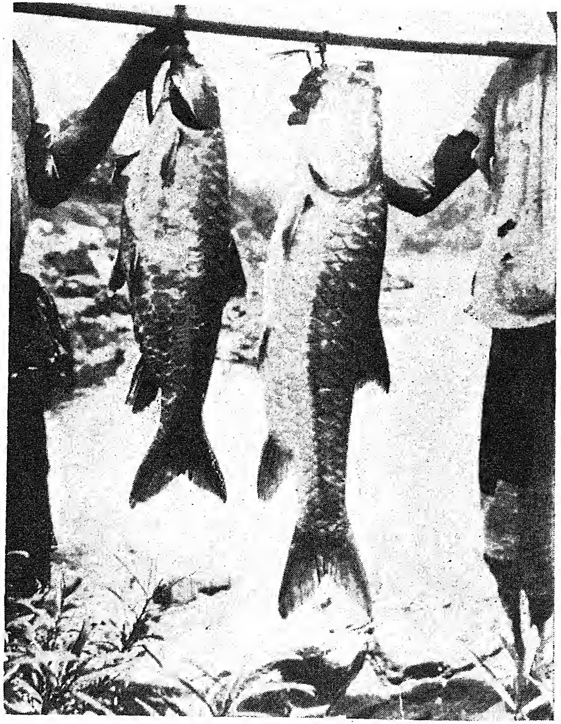
Firstly there is the common Himalayan Mahseer with a decided black line down the side. The second is the Thick-lip which is also well known. Then comes the Black Mahseer which is common both in India and Burma, where the banks of streams are overgrown with thick forest. The other three as will be seen from the photographs, are quite different in shape having a small head and thick stocky tail like a salmon.

I have called these fish the Copper Mahseer (which Thomas mentions as occurring in Assam, only the fins mentioned are

At the entrance of the N'Mai into the Confluence. (A morning's catch in the foreground.)



Our last morning's catch on the Confluence. Four ordinary Mahseer (38, 21, 9 and 6 lbs. respectively), with a 15-lb. Black Mahseer in the centre. (*Note its dark colour. The black line down the side is clearly noticeable in the ordinary variety.*)



A 16-lb. Chocolate Fish and 23-lb. Ordinary Mahseer.

(*Note stockier build and smaller head and mouth of the former.*)

A 44-lb. Thick-lip (l) and 25-lb. Copper Fish (r).

(*Note modified thickness of lips in right-hand specimen ; also concave snout and small head and mouth. The adipose extension of the lower lip can also be made out in the larger fish.*)

vermillion in colour, whereas this fish's fins are sky blue), the Chocolate and the Red Mahseer. I give the descriptions for what they are worth.

1. *The Golden or Himalayan Mahseer.*—This is the commonest and the same as the Indian Fish.

He is long and narrow as a rule with a distinct black line down his entire length, two half scales in width above the lateral line.

Head large and long, top half green, lower half pale green running into silver.

Above lateral line colour from golden with a mauve tinge on silver-grey background to a deep golden tinge running into dark green on the back. Below lateral line, a beautiful olive-gold with a dull silver background. Fins blend with colouring; dorsal, green and dirty pink, ventral and pectoral pale green to olive with red fringe. Eye: Iris golden, pupil black. Belly white.

2. *The Thick-lipped Mahseer.*—Same colouring as Himalayan Mahseer differing only in the head. Chief features are the thick lips with the adipose extension which is well illustrated in Thomas' 'Rod in India'.

These are also common, best taken 44lbs.

3. *The Black Mahseer.*—He is quite a different fish and of a stocky build. Head small and black, mouth small. Barbels and eyes black.

This fish is marked by a jet black line two half scales above the lateral line, scales above having a tinge of gold on the scale tips running to jet black on the back. Below lateral line scales are lighter but dirty white, almost shot black to the scales on belly, which are drity white with a black fringe. Fins black with grey at base. Best fish taken 19 pounds.

4. *The Copper Mahseer.*—This is quite the most beautiful of all; he is bright copper all over with a sheen running into all the colours of the rainbow. He runs from the deepest shades of copper with a delicate mauve sheen throughout to the more delicate shades of copper with shell pink, on a background of shot silver and gold. The head is small, the nose slightly concave, the lips are a modification of the thick-lip variety, the adipose continuation of the lower jaw is clearly defined but very much modified and not as much pronounced as in the thick-lipped variety. Fins deep blue, except tail fin which has a red fringe. Belly delicate shade of yellow, eyes bright copper; pupil deep indigo blue.

Three of this variety were caught; best fish 25 pounds.

5. *The Chocolate Mahseer.*—Head round and square, like a Labeo. Colour, bronze running through delicate shades into purple. No black line above lateral line. Above lateral line chocolate running into blue to dark chocolate on back, with polished bronze tinge to scale tips. Below lateral line, running from faint silvery blue to white on belly to the extent of three complete rows of scales, with half row on either side, clearly defined making four.

Bright orange spots under lower jaw on chin; lips thin.

Fins sky blue; iris chocolate; pupil black. Two fish of this kind taken; best 28 pounds.

6. *The Red Masheer.*—Head small and round, top of which is shot gold and purple, also gill plates; mouth small. Above lateral line, beautiful sea-green, shot with silver, tips of scales salmon pink. Below lateral line, mauve with silver, vermillion tips to scales; belly pink; fins all bright red.

Eye golden; pupil indigo blue. Took five of these fish; best 18 pounds.

We took besides, two distinct varieties of goonch (*Bagarius yarrelli*). One has the green backing instead of the yellow, as in the Ganges fish, with the black. The green is dark and could be described as dirty with small black spots. The other colour is black. The feelers are green, with black spots, also the fins. My first introduction to these brutes was on April 28th. The second type has no black but is dirty green all over, but has otherwise the same marking as his cousin. The largest taken was 48 pounds.

Butchwa (*Pseudeutropius garua*) run large; best taken, 5½ pounds. The average weight of a dozen fish worked out at three pounds.

Silund (*Silundia gangetica*). Only one caught here, of 3 pounds, but have had 22 and 15 pounds fish at Namti, in a tributary of the Irrawadi.

Barilius bola. These sporting fish are found in large quantities in all the rivers in this district. I have caught them over 2 pounds, though Thomas puts this as their maximum weight.

There is no Chilwa (*Chela argentea*) in this river, but this is replaced by a small fish about two inches long, with a black stripe down the side; I don't know it, it is seen going up in swarms along the sides, on occasions.

The extraordinary thing was that in only one fish of all we caught, did we find a small fish in its stomach. There was nothing but slime, grit, and leaves found. They certainly do feed on rank vegetation, as one can sometimes see them cruising about and looking for the favoured titbit, among the many kinds collected in still backwaters. I had a demonstration by a Burman, of their leaf-eating habits at Namti (another good fishing spot in this district) on pumpkin leaf. The current was slow, running into a deep pool, he broke up this leaf, and threw in pieces. After it had drifted a little way down, the water was alive with fish clambering over one another to get it. (A useful tip for your note book).

For two days (April 26th and 27th), the *Butchwa* were feeding by the hundred on shoals of small fish, which resembled *Labeo* about 9 or ten inches long, but I never once saw a Mahseer join them.

Whether the Mahseer here feed on small fish or not remains a problem to be solved. Dead bait spinning never did any good, the fish that were taken (all on spoon), were feeding very deep.

They may prefer the Stone Loach, and find him in sufficient numbers not to worry about the migratory fish, though this can hardly be so.

Most of the fish (of all the species) we took were full of spawn. It was a pity to be removing so many thousands of eggs from the river, but the method of killing our fish prevented our putting them

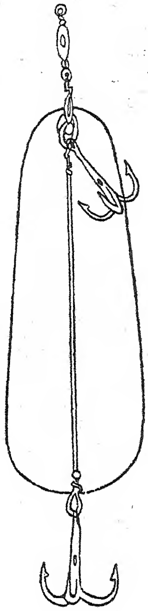
back, as the boat-man with his *dah* (knife) hits the fish over the head, before lifting it out.

There was never any likelihood of waste, however, as the staff of muleteers and the local people were always glad to have them. My best day was five fish, 50,42,34 18½, and a 1 pound *Butchwa*, a total of 142½ pounds, but there was nothing wasted.

Tackle.—The heaviest of tackle is necessary to do any good, as one may get into any sized fish, and unless one can force matters from the beginning, a fish is apt to get to snags, of which there are many.

I used a 14′ Green-heart rod of Manton's which cannot be beaten for this work. The water is so big and deep, that to get down to the fish in the rapids, one has to use a four or five ounce weight, this with a four-inch spoon makes it heavy work for any rod. Split cane rods are very much in disfavour up here, my trout rod (Hardy's Perfection, split cane and steel centre), opened up from the butt to the first ring, while playing a 3½ pound *Butchwa*, the steel core falling out like match sticks. The heavier rods also have given the same trouble, I had a '*Hi Rigan*' and a 'Murdoch', but did not have occasion to use them. A spare rod and a couple of spare lines are necessary.

Reels.—The extra wide 'Silex' (4½ inch) was what I used but I would prefer a 'Sea Silex' for this water with 300 yards of stout line. With the heavy weight necessary to fish in these waters, the constant over-running which is inevitable, however expert one might be with the ordinary Silex, can be far better controlled on the Sea Silex. An over-run besides being a nuisance invariably fouls and cuts the line on the drum.



Bait.—Large spoons of any variety are the best. A black and sliver spoon is favoured by a section of fishermen here, known as the 'Putao' spoon. R.T. did little good with this before I arrived. It takes well, up above I understand.

Personally I found a Brass and Silver (E and D) pattern with scale effect on the outside the most killing, as indeed between us we twice finished my supply of spoons (4 dozen odd). I am certain that the scale effect on the spoon in this water is most effective. I know I am going against the great authority Thomas in this, but in this clear water the scaly effect is clearly noticeable when the spoon is spinning. The fish certainly took on this spoon when we failed to do any good with others; and we had a fine selection in shapes, colours and sizes.

Messrs. Manton & Co., Calcutta have made up from a sample of mine these spoons and are calling them the 'Myitkyina' spoon I believe.

Mounts.—These are of course one's fancy. Personally, I found that a simple flying mount made up from soft galvanized steel wire the best. A thickness of a stout spinning line, making two loops

with a single treble mounted in each, a No. 4 or No. 6 in the top loop and a large treble as a tail hook in the lower loop (see diagram).

The top loop of the mount and spoon mounted direct on to the spring swivel of the trace. Provided the eye of the spoon is large, mounts and spoons can be changed in a few seconds. I never once lost a fish by the swivel drawing.

This method of mount does away with the chain of swivels leading a spoon, which is the case when the usual mounted type of spoon and trace, as sold by tackle makers is used.

Manton's have improved on this idea and made a special attachment with a sliding collar. This does away with any possibility of the mount drawing, though rather more visible than a link swivel.

Let me here offer some advice, to anyone intending to make a trip here. It is to take at least eight dozen large spoons with you and more if you wish to be comfortable. It is most essential to fish deep and just feel the bottom if you want to do any good and catch the big fellows. This causes one to be continually hung up and though the boatmen are expert at releasing the hookhold, in many of the best places the water is too treacherous and strong to allow this.

Traces.—Medium and stout Kiln wire traces made up on the spot about 30 inches long with two swivels, I found the best.

Fly.—This lure would be quite worth a trial. I saw on several occasions Mahseer (the Red and Chocolate) jump clean out of the water at dragonfly. I am not experienced in this line of angling so can only offer this as a tip. I saw fish over 40 pounds rising in this way.

A NEW SPECIES OF *BALANOPHORA* FROM MAHABLESHWAR, BOMBAY PRESIDENCY

BY

E. BLATTER, S.J., PH. D., F.L.S.

(*With a plate*)

Balanophora Elkinsi Blatter *sp. nov.* [Similis *Balanophoræ indicæ* Wall., sed differt pedunculis multo brevioribus, floribus masculis epedicellatis, perianthio masculo flavo lobis oblanceolatis apice obtusis necnon incrassatis, capitulis femineis multo largioribus.]

Perennial. Rhizome a large irregular tuber consisting of many rounded lobes or balls, light brown, finely warted all over with whitish star-shaped groups of pustules (perhaps lenticels); colour of juice when fresh pale yellow, turning orange on exposure. Peduncles (flowering stems) numerous, breaking through the rhizome, some bearing a male head, others a female one, greenish yellow, male peduncle up to 5·5 cm. long and 3 cm. diam., female one up to 4 cm. long and 3·5 cm. diam., both covered by densely imbricating scales which are dirty yellow or greenish yellow, ovate-oblong or strap-shaped, or oblong-obovate, usually rounded or blunt at tip, sometimes acute, up to 3½ by 2 cm., distinctly parallel-veined, glabrous, shining. Male flowers crowded, sessile, sunk in oblong terminal heads sometimes reaching 7 by 6 cm., in other cases not thicker than the peduncle, viz., 2 by 2·5 cm. (including the open flowers), flat on top as long as only the lower flowers are open, yellow, hexagonally and pentagonally honey-combed inside. Bud yellow with dark brown tip. Bracts fleshy, yellow with purple tip, broadly strap-shaped, about ½ the length of the tube. boat-shaped, truncate, more or less incised in the middle, tip much thickened. Perianth-tube up to 1–2 cm. long; lobes 4 or 5, ⅓ the length of the tube, reflexed, dirty yellow, turning dark brown on drying, oblanceolate, tips blunt, thickened and purplish. Stamens white, forming a column, attached to the perianth-tube a little below the throat; anthers connate with white sinuately arranged fringes. Female flowers densely packed in nearly globose dark brown heads of various size, up to 5 cm. diam., sometimes depressed or flattened on top. Ovary ovoid or obovoid or variously compressed by the small clavate brown bodies which reach the surface of the head, white, stalked, stalk about as long as the ovary, white; style slender, brown, 3–4 times as long as the ovary. Perianth absent.

Locality: Found by Dr. F. C. Elkins at Lingmala near Mahableshwar in the shade of a dense thicket, parasitic on *Eugenia Jambolana* Lam., on January 23, 1928. (Herb. Blatter No. 788, type).

In connection with this species the question arises as to the identity of three specimens mentioned by Cooke in his Fl. Bombay Presy., vol. ii, p. 557 which he mentions under *Balanophora indica,* Wall. One is: 'Mahableshwar, Mrs. W. E. Heart, fairly plentiful in the wood above the Dhobi's waterfall in November, H. M. Birdwood; Khandalla, on roots of *Carissa Carandas*, Woodrow.'

Cooke has not seen Birdwood's and Woodrow's specimens and he must have included them on the authority of the two botanists. As to Mrs. Heart's specimen we have at least some account of over 40 years ago published in this Journal, vol. i (1886), 75 under the name of Mrs. W. E. Heart, and another on p. 78 by Dr. Macdonald. Mrs. Heart has, in addition, given a drawing of her plant. The general habit is well represented, but no details are given which might help in specific distinction. The scales on the peduncle do not quite agree with those of the new species. Her description, as far as it goes, certainly matches with our plant. She says. 'In October a tuberous-rooted plant of curious structure, which I have endeavoured to sketch below, was brought to

me at Mahableshwar, from one of the valley jungles below the hill. The rains had continued more than usually late, which may account for there being then still visible a plant which neither I nor any one to whom I showed it had ever seen before. It grew in clusters in moist red laterite clay, through which occurred the numerous root fibres (lately severed) of some large dicotyledonous tree. The man who brought me the plant declared that he very rarely met with it, never except during the rains, and then only in the thickest jungle, and always at the foot of some large tree. But he was unable to state whether the large tree was always of the same species. The first thing to appear above the soil was a yellow spathaceous stalk, bearing on its summit a ball, about the size of a marble, almost concealed among the spathes. Most of these balls were of a velvety texture and a rich brown colour. Two were rough, not unlike fir-cones. The balls continued to grow in circumference as the stalks grew in height, till the latter were about 3 inches long and the balls about the size of bagatelle balls. A number of minute white flowers then opened over the whole surface of the rough ball. Having no microscope or magnifying glass with me, I was unable to identify the plant from the examination of its extremely minute structural parts. Dr. Macdonald determined the open flowers on the rough heads to be staminal only, and conjectured the velvety balls to be composed of pistillate flowers only, and from the stamens being sinuous and united into a central column, he was inclined to think the plant might possibly belong to the Natural order Cucurbitaceæ. But as he also had no magnifier, he was unable to speak with certainty, and failed to identify the plant I much doubt if there is any Cucurbitaceous plant without the climbling habit so characteristic of that order. On the other hand, the small Natural orders Cytinaceæ and Balanophoraceæ, especially the latter present some features similar to those noticed in my Mahableshwar plant.'

Though all the details mentioned apply to the new species and though Mrs. Heart's drawing could (with the exception of the scales) be taken as a picture of our plant, I do not feel sufficiently confident to say, on the data at our disposal, that her plant is identical with ours; neither are we allowed to follow Cooke in identifying it with *Balanophora indica*, Wall. It remains, therefore, doubtful whether there grow two or one species of *Balanophora* at Mahableshwar.

The biological side of the *Balanophoraceæ* is little known. Pollination, somatic apogamy, and seed dispersal require further investigation and the physiological relations between host and parasite have still to be cleared up. Even the merely morphological and taxonomic facts of many species are not at all clearly defined. There is ample scope for Indian botanists to throw more light on this interesting group of plants. I may be allowed to refer to some literature on the subject :

Ernst, A. Embryobildung bei Balanophora. Flora vol. cvi, 1913.

Heinricher, E. Van Tieghems Anschauung über den Bau der Balanophora-Knolle. Sitzungsber. d. Wiener Akad. vol. cxvii (1908).

Heinricher, E. Beitr. zur Kenntnis d. Gattung Balanaphora. Sitzungsber, d. Wiener Akad. vol. cxvi, (1907).

Lotsy, J. P. Balanophora globosa, eine wenigstens örtlich verwitw. Pflanze, Ann. Jard. Bot. Buitenz. vol. xvi (1899).

Lotsy, J. P. Rhopalocnemis phalloides. A morphologico-systematic study. Ann. Jard. Bot. Buitenz. vol. xvii, (1901).

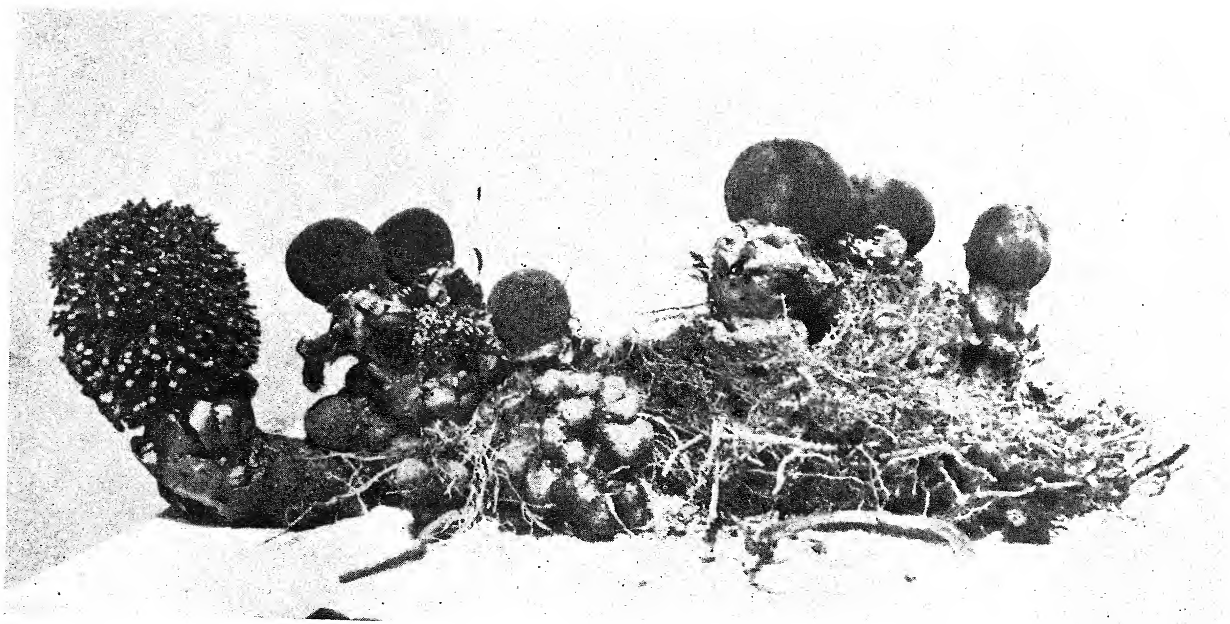
Schlechter, R. Eine neue Balanophora, Bot. Jahrb, vol. i (1913).

Strigel, M. Der anatomische Bau der Knollenrinde von Balanophora. Sitzungsb. d. Wiener Akad. vol. cxvi, (1907).

Strigel, M. Der Thallus von Balanophora. Sitzungsb. d. Wiener Akad. vol. cxvii (1908).

Tieghem .Ph. v. Sur l'organisation florale des Balanophorées et sur la place de cette famille. Bull. Soc. Bot. Fr. vol. xliii, p. 205.

Treub, M. L'organe fém. et l'apogamie de Balanophora elongata. Ann. Jard. Bot, Buitenz. vol. xv (1898).



Balanophora Elkinsi, Blatter sp. nov. To the left a male cone, all the other heads female.

THE STUDY OF INDIAN BIRDS

BY

HUGH WHISTLER, F.Z.S., M.B.O.U.

Part II

(With two plates)

(Continued from page 176 of this Volume)

SOME EXTERNAL CHARACTERISTICS OF BIRDS

I. The Feathers

One of the most obvious and striking of the characteristics of a bird is its covering of feathers, and these are peculiar to the class. Feathers have undoubtedly been developed in birds in definite relation to their powers of flight, developing with it both as a cause and as an effect. Now the primary attribute of a clothing of feathers is that it is the means of enclosing a curtain of air to be used as a non-conductor of heat; it is therefore regarded as one of the means whereby the birds attained their relatively greater warm-bloodedness than the reptiles and therefore the more active intensive life which led to the general development of powers of flight. While on the other hand it is obvious that the possession of powers of flight made it in turn more necessary that a bird should be clothed in a manner sufficient to protect it from the extremes of temperature to which it would as a result be exposed.

Now a word of explanation is required as to what is meant by that quality of 'warm-bloodedness' which birds and mammals share as opposed to reptiles, amphibians and fish which are 'cold-blooded'. It has no reference to the actual temperature of the blood, but it refers to the ability to maintain the temperature of the body at a constant level irrespective of external changes; in other words it means that there are arrangements for keeping a balance between the loss of heat and production of heat. The actual mechanism for regulating this balance lies in the connection between nerves, blood and muscles, but it is obviously helped by the insulation, as we may call it, of birds and mammals by their non-conducting envelope of feathers and fur. The regulating machinery works as far as possible protected from external influences. In day and night, in heat and cold the body heat must remain a constant factor. If it is varied the bird or mammal is ill, and illness soon means death outside the paths of civilization.

Flight implies exposure to intense cold during its progress and also to sudden extremes and changes of temperature in its cessation. Hence the need of special clothing for the bird as much as for the

aviator, and nothing more admirable for warmth and lightness can be imagined than a garment of feathers. The down and the downy base of the contour feathers give warmth, the contour feather provides a firm envelope,—the stream-line which minimizes the resistance to the air. At the same time feathers have made possible the flight of a bird as that perfect flight which no imitation of man's devising will ever equal, ability to start and stop in any position, under any circumstances.

That feathers are not absolutely essential to the perfection of flight is obvious to any one who has watched some of the smaller bats feeding with their absolute mastery of quick change of direction; they perhaps surpass the birds in their conquest of the air, with a development of the clumsy parachute of the Flying Squirrel, —a line of development perfected, with differences, by the Pterodactyl, while the bird was still in reptilian guise. Certain of the non-vertebrate groups such as *Hymenoptera* and particularly the Hawk-moths (*Sphingidæ*) have a perfection of flight not surpassed by any bird, and this they have attained by a still different method. But regarding the various natural orders as a whole we see that the birds have attained a general proficiency of flight so markedly higher on the average than that of all other orders that we are entitled to award them the palm, and for this they must thank the evolution of the feather.

The light elastic build of a feather, with its vanes composed of barbules linked by hooks, the almost air-tight surface that it presents, and the extent of flying surface obtained at a sacrifice of weight obtainable by no arrangement of bones and muscles, are all in turn responsible for the bird's superior mastery of the air.

There are other subsidiary uses of feathers but these are the two main, an aid to the regulation of the heat of the body, and the making possible of perfect flight.

Feathers correspond not to the hair of mammals but to the scales of reptiles, though the exact relationship between feathers and scales is not clearly understood.

That they are closely connected is obvious from a microscopic examination of the genesis of both scale and feather, which in each case is found to spring from the epidermis starting as a slight pimple or papilla fed by a nutritive core of dermis on the delicate skin of the embryo; while an inferential proof of the connection is to be seen in the fact that scales and feathers are to a certain extent interchangeable as a covering for the foot and tarsus. This is very clearly seen, as stated in the last chapter, in the family of the Gallinæ. In three such closely related birds as the Pheasant, the Black Grouse and the Ptarmigan we find that the foot is clothed respectively in scales, in a mixture of scales and feathers, and in a dense covering of feathers alone. In the Buzzards (*Buteo*) the interchangeability of feathers and scales on the tarsus may be found in the limits of a single genus. It is customary also to cite the scaly covering of the foot and tarso-metatarsus of a bird as a relic of the reptilian heritage of scales. Though it must be admitted that there is some divergence of opinion as to whether a feather is a modified scale or an entirely original form of growth even

though it may be derived from the same dermal pulp and epidermal papilla.

The normal structure of a feather is as follows: It consists of two parts, the main stem or quill (*scapus*) and the vane (*vexillum*) consisting of an inner and outer web on each side of the quill. The main stem or quill itself consists of two parts, the *calamus* and the *rachis*.

The calamus is the lower part of the quill which is hollow and transparent with an aperture (*umbilicus inferior*) at its junction with the skin where it is embedded in a follicle. By this aperture the pulp of the dermis enters the base of the calamus in the growing feather, and the colourless horny caps in the centre of the calamus are the cells which contained the pulp and mark its retreat as it was gradually used up for nutriment. The shrivelled end of the last of the caps projects from another aperture (*umbilicus superior*) which marks the point of junction of the calamus and the rachis.

The rachis is the remainder of the main stem which supports the vane. It is roughly quadrangular in section and is marked along its length on the under surface with a furrow due to the method of growth. Pycraft explains that the rachis is formed by a process of continuous growth of the dorsal surface of the calamus, and the resultant lateral edges of this projecting outgrowth ultimately curl inwards, meeting in the middle line of the under surface of the feather and leaving this furrow to mark the junction. The enclosed hollow is filled with a kind of white pith which combines strength with lightness.

The vane is built up on a system which is unsurpassable for its combination of strength, elasticity and lightness. It is composed of *rami* or barbs joined to each other by a series of *radii* or barbules by means of interlocking *cilia* or barbicels. The rami are the long slender plates or branches which project on both sides of the main stem, not at right angles but with a very marked inclination towards the tip of the feather. If the vane is pulled by the fingers in a direction away from the tip of the feather it will be observed to stretch and then reluctantly part, splitting neatly up the line on one of these plates; the process can be repeated until the rami are all isolated and the web is all split up. Then even to the naked eye the edges of the rami have a faintly furry appearance. This is due to the radii or barbules which project on each side of the rami. Microscopic examination shows that the barbules have a wonderful adaptation of their edges into barbicels or cilia, some of which end in hooks (*hamuli*); the hooks of the barbicels on one barbule lock with the upper scroll edge of the barbules of the next barb. This takes place over practically the entire vane of the feather, the result being an elasticity and strength which a solid plate could not give without a considerable sacrifice of lightness. Gadow once counted the barbs on the inner web of a primary feather of the Crane and found them about 650 in number; each barb he found contained about 600 pairs of barbules, and he calculated that there were over a million barbules on the whole feather. And who has had the patience to number the feathers on a single bird!

In many feathers there is a further part known as the *hyporachis* or aftershaft which springs from the under surface of the main feather at the *umbilicus superior*. This varies greatly in its development. It may be equal in size to the main feather as in the Emus and Cassowaries, or it may appear merely as a minute downy tuft. In many families it is entirely wanting. In its most developed form there is a main stem with barbs and barbules, but the barbicels are always absent so that the vane never attains the firm elastic surface of the ordinary feather. As a rule it is best developed in the smaller contour-feathers, while it is absent or minute in remiges and rectrices. Conspicuous examples of the aftershaft will easily be found amongst the body feathers of the game-birds.

Now all feathers are based on the component parts described above. The many modifications of shape and purpose are obtained by a variable use of these parts. The stiff flight feather of the wing and the small soft body feather are alike in their basic structure, the parts being merely modified in connection with their different uses.

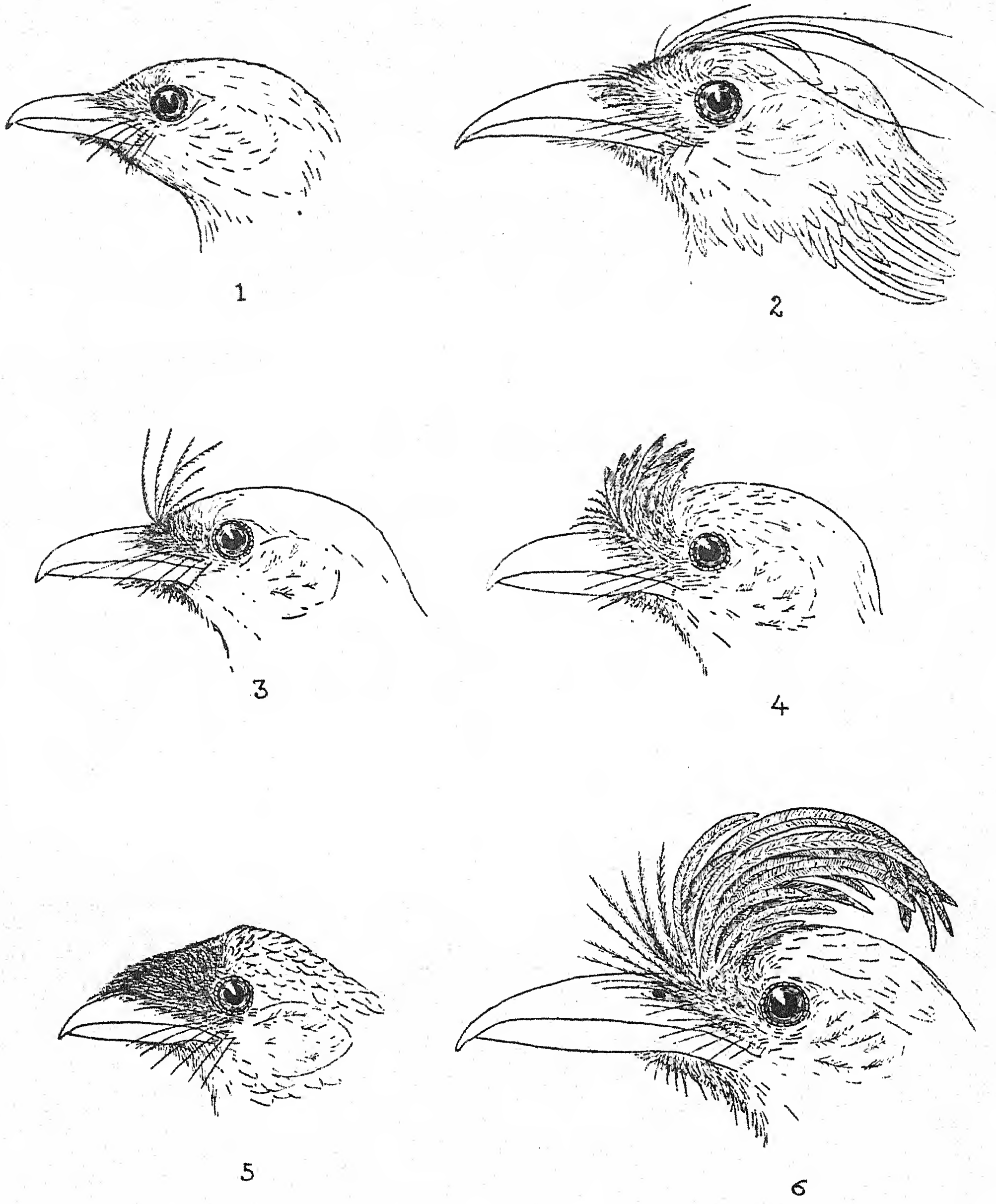
It is customary to classify feathers from two points of view, first into types and secondly into generations.

Classified from the point of view of type, feathers may be divided under three main headings: Contour feathers, Downs and Filoplumes, though there are many connecting links between these classes.

Before proceeding to describe the feathers under these headings it is as well to emphasize the fact that feathers do not grow evenly over the surface of a bird as fur over a mammal. With the exception of the struthious birds and their allies, the Penguins, and the South American Screamers (*Palamedea*), practically every bird has its feathers arranged in definite tracts (*pterylæ*) with featherless spaces (*apteria*) in between them. The reason presumably is that a feather is always broader than its base, and not the same size for its whole length like a hair; some such arrangement of tracts and spaces is therefore necessary to allow the plumage to sit properly. The variation of the tracts and spaces is considerable and a study of their distribution under the name of Pterylosis is of considerable value as an aid to classification. Pterylosis does not only deal with the disposition of the contour-feathers but also with the distribution of down on the featherless spaces and amongst the contour-feathers.

The contour-feathers are those which form the main covering of a bird and give it its main contour and appearance. Feathers make the bird in very truth from the point of view of the human eye. Pluck a Bird-of-Paradise, a crow and a seagull and the bare bodies convey little of difference to the ordinary person. Contour-feathers have generally speaking the full development of the typical feather as described above, and they include not only the body covering but the strong flight feathers of wings and tail.

Amongst the contour-feathers are found all the examples of beautiful feathering which at once occur to the mind, first and foremost of which of course are the wonderful plumes of the Birds-of-Paradise. But it is not necessary to go beyond our Indian birds



HEADS OF DRONGOS *(Dicruridæ)* to illustrate feather modifications:

1. *Dicrurus macrocercus.*
2. *Chibia hottentotta.*
3. *Dissemuroidis andamanensis.*
4. *Dissemurulus lophorhinus.*
5. *Bhringa remifer.*
6. *Dissemurus paradiseus.*

for a sufficiency of examples. Leaving aside the question of colouration, it is easy to see how beauty of plumes may be obtained simply through a beauty of form gained by a mere modification of the proportions of the individual parts of the feather. An excellent example of this is afforded by the family of the *Dicruridæ* or Drongos to which belongs that familiar species, the King-Crow (*Dicrurus macrocercus*). A general colour of blue-black runs throughout the family whose members attain their adornment by modifications of the shape of the contour-feathers, possibly as a result of their distant kinship with the Birds-of-Paradise (*Paradiseidæ*).

The new edition of the *Fauna* gives 7 genera and 11 species of the *Dicruridæ* as found in Indian limits. In this small number we find two directions in which the family attains adornment merely by the shape of the contour-feathers, namely in the feathers of the forehead and crown and in the feathers of the tail.

To take the tail first we find in our faunal limits the following important modifications. The normal Dicrurine tail consists of 10 feathers of which the central pair are the shortest and the outermost the longest, the intermediate feathers being graduated to perfect a deeply forked tail; the ends of the outer feathers are sloped off on their inner webs so as to accentuate this fork. This tail is familiar to all of us as the possession of both the common King-Crow or Black Drongo (*D. macrocercus*) and of the Grey Drongo (*D. leucophæus*). Slight changes on it are rung in other species by varying the proportions of the fork.

The first real modification of it is found in the Hair-crested Drongo (*Chibia hottentotta*). In this the tail has the fork so slight that the tail when partly spread becomes almost square at the end save for the outmost pair of feathers. These curve upwards and inwards over themselves so that if the tail is closed the tips of these outer feathers practically touch in the air above the central pair. A slight tendency to this twist of the tips of the outermost tail feathers is often visible in the tail of the King-Crow type.

The other important modification is found in the tail of the Racket-tailed Drongos, *Bhringa* and *Dissemurus*. In these the fork of the tail is so deeply exaggerated that we altogether lose the idea of a fork at all, and look on the tail as almost square as in *Chibia* with the addition of two curious streamers. Yet the streamers are merely the outer pair of tail-feathers exaggerated out of all proportion to double and more the length of the next pair of feathers, and with the vanes cut away from the middle portion of the rachis. The 'racket' at the end of the feathers is merely formed by a resumption of the vane in the normal way. It is interesting to note that the method of producing the racket is different in the two genera. In *Dissemurus* the racket is composed of the outer web of the feather, the inner web being absent except for just sufficient at the end to emphasize a twist of the racket which recalls the twist of the outer feather tip in *Chibia*. In *Bhringa* the racket is flat and composed of an equal amount of web on each side of the rachis. A glance at the illustration should make the differences clear.

The method of growth and formation of these rackets is not yet understood and may be commended as a subject for careful

observation in the field. It has been suggested that the bird forms the racket itself by trimming the vane off the rachis with its beak. Strange as this suggestion may appear it has been observed to be the solution of the formation of the rackets in the tail of the Motmots, a purely Neotropical family of Picarian birds superficially reminiscent of the Bee-eaters. We may at any rate suggest that the various marked characteristics of the Dicrurine tail have some connection with their wonderful mastery of the air. All are adepts at mounting steeply in the air and swooping directly downwards.

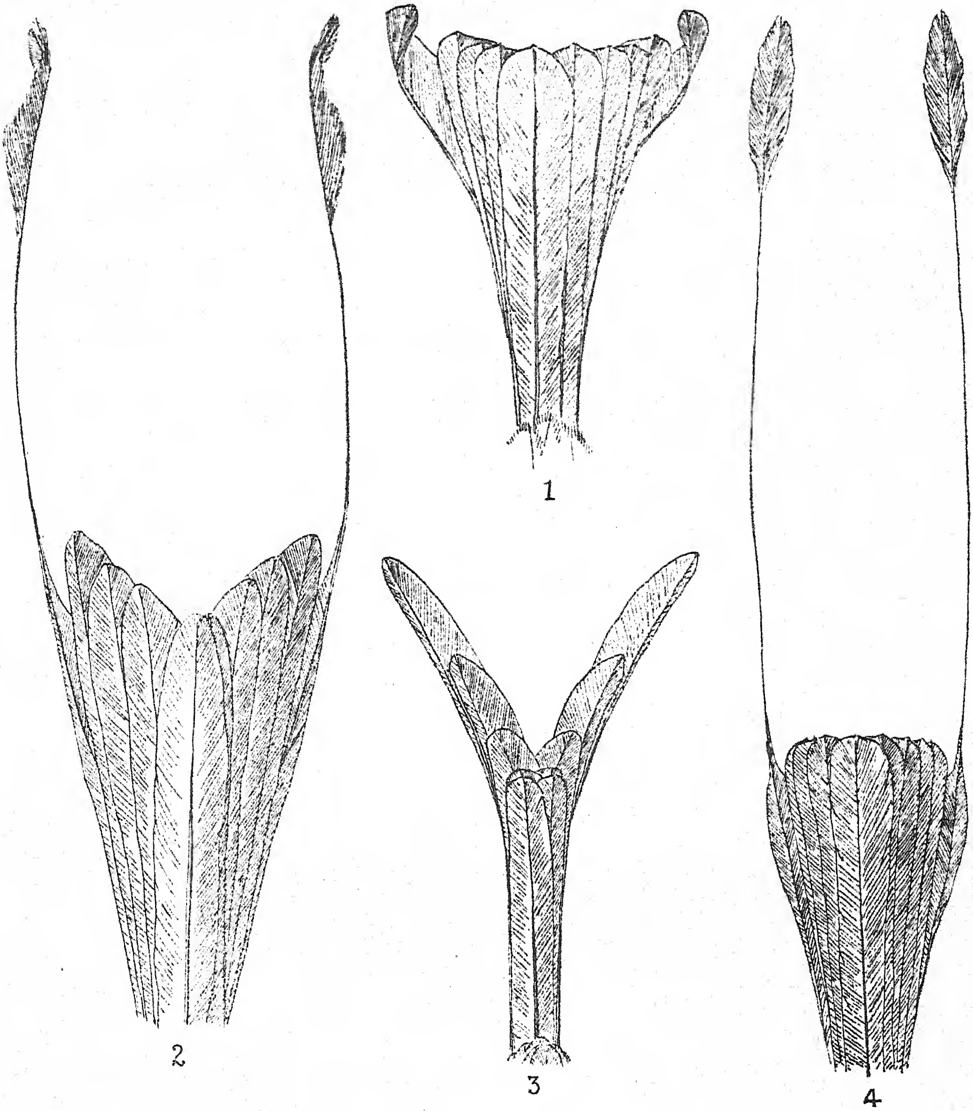
Of *Dissemurus paradiseus*, the Larger Racket-tailed Drongo, Robinson says, ' It is seen to great advantage in the early morning and late afternoon, when it is very active, towering upwards into the air, and then rushing downwards, the rackets on the outer tail-feathers appearing like two enormous bees in attendance on each quarter.'

There is a similar play on feather formation to produce marked differences on the crown in the *Dicruridæ*. We start again here with the Black and the Grey Drongos as having typical heads with no special feature in the feathering of the forehead and crown. The Bronzed Drongo (*Chaptia œnea*) merely improves on this by having the feathers of the crown longer and more pointed thus paving the way for the Hair-crested Drongo (*Chibia hottentotta*) which in addition to having the feathers of the crown as in *Chaptia* has the feathers on the sides of the neck also pointed and elongated but to an extravagant degree which turns them into long lanceolate hackles.

In other genera the modifications are formed in the feathers of the forehead. *Dissemurulus lophorhinus*, the Black Drongo of Ceylon and Travancore has a tuft of ordinary feathers about half an inch long on the forehead. This in the Andaman Drongo *Dissemuroides andamanensis* is replaced by a tuft of hair like feathers, half an inch long, which are merely degenerate feathers with the vane almost suppressed. A stage further is reached by *Chibia* where (in addition to the hackles mentioned above) this tuft is reduced to half a dozen hairs, 2 to 3 inches long, which spring from the forehead and lie back over the head and shoulders. These hairs are really only degenerate feathers in which the rachis has no barbs.

In *Dissemurus paradiseus*, the Larger Racket-tailed Drongo, we again find the frontal crest springing from the forehead composed of ordinary feathers, but they are long, dense and hackle-like and curve elegantly backwards above the head to the nape. It is interesting to note that the foremost of these feathers are degenerate in type resembling those of the crest of *Dissemuroides* while one or two are practically hairs. The Lesser Racket-tail, *Bhringa*, has no crest but relies for ornament on the thickness and density of the forehead feathers which slope forwards and lie nearly over the whole length of the bill. An incipient tendency to this formation may be traced in several of the other Indian members of the family.

It would be easy to multiply examples of ornamental plumes, all of which are contour-feathers. The possibilities of ornament arising from a mere use of structure (apart from colour-producing structure which will be dealt with under the head of colour) are



TAILS OF DRONGOS *(Dicruridœ)* to illustrate feather modifications:

1. Chibia hottentotta. *2. Dissemurus paradiseus.*
3. Dicrurus macrocercus. *4. Bhringa remifer.*

apparent from the example of the *Dicruridæ*, and it will be sufficient just to cite one or two more examples.

The simplest form of modifying the shape of a feather to attain beauty is to lengthen it as in the long tail feathers of the Blue Magpies (*Urocissa*). Keep the length and narrow the vanes and you have elegant streamers as in the Paradise Flycatcher (*Terpsiphone*). Still further modify the vane until it has practically vanished and you have the 'wire' of the Wire-tailed Swallow (*Hirundo smithii*). A long feather may be narrow and pointed and you get the pintail of the Parrakeets (*Palæornis*) and of the Sandgrouse (*Pterocles*). A long pointed feather with different proportions between the inner and outer webs and a differing amount of strength in the rachis easily modifies the elegant tail of the Kalij Pheasant (*Gennæus*) into the familiar tail of the Jungle-Fowl (*Gallus*). The modification of a feather in a lateral direction is much rarer probably because interference in that direction is to affect the property of a feather as regards flight—the ultimate end to which all feathers have been evolved. I can only think of one example of a feather of which the vane has a conspicuous lateral projection and that is the enormous tertiary plumes of the Mandarin Duck (*Æx galericulata*).

Another method of attaining beauty is by softness of texture. This is gained by sacrificing the cilia of the vane with their hamuli and also by decreasing the number of the radii. The result is a 'decomposed' feather, most familiar to us in the wonderful dorsal plumes of the Egrets (*Herodias*) and other less famous members of their family. A similar modification on a different type of feather produced the 'marabout' or downy under tail covert of the Adjutant-Storks (*Leptoptilus*), and the similar under tail coverts of the Peafowl (*Pavo cristatus*). Here the result to a human eye is also beauty though nature's purpose is not apparent unless it be warmth. The same type of feather is again found in the downy ruff of various vultures, and one can only assume that the purpose here too is warmth, to close the junction between the naked skin of the head and neck and the commencement of the covering of contour-feathers—in other words to shut out draughts.

Occasionally the modifications of feathers although clearly intended to produce beauty, have in human eyes somewhat of a bizarre effect, as in the crest of the Peacock.

Other modifications of feather are very curious and as yet leave us without any clue to their meaning. For instance in the Waxwing (*Ampelis*) the tip of the rachis is expanded into a hard waxen point. A similar structure is familiar to all who know the Grey Jungle-Fowl (*Gallus sonnerati*) with the yellow wax-like tips to the hackles of the cock.

Although nearly all feathers show a tendency to a curve in their length, a true curly feather is almost unknown, amongst wild birds again doubtless for the reason that it would be incompatible with flight. Two of the slight exceptions occur in our Indian fauna, in the curly feathers of the head and neck of the Dalmatian Pelican (*Pelecanus crispus*) and in the central tail feathers of the drake Mallard (*Anas platyrhynchus*), though the ease with which a curly-feather

could be produced from the typical feather structure, did nature deem it desirable, is shown by the curly plumaged types of fowl which the poultry-fancier has evolved.

Most of the modifications thus instanced have all been directed apparently towards the attainment of adornment, though at the same time many of them may have a greater influence than we know on the powers of flight. But instances can be found in which the modifications of feather structure are intended for utility alone. One of the most marked of these is the pointing and stiffening of the tail feathers to assist in climbing as in the order of the Woodpeckers (*Pici*), a result which is attained in a similar manner by the totally unrelated Tree-creepers (*Certhiidæ*). Its efficacy may be proved directly by the shortest observation of a living member of one of these groups, neither woodpecker nor creeper moving a step without the support of the stiff tail-feathers. And a comparison between the easy skill with which a Tree-creeper moves up a trunk and the fluttering progress by which a Wall-creeper (*Tichodroma muraria*) ascends a bank or cliff shows how much the latter lacks in its possession of an ordinary soft tail.

The second group of feathers includes the Down feathers, which are smaller and softer than the contour-feathers and generally concealed by them. They possess no hamuli which accounts for their fluffy appearance, and they frequently have no rachis in which case all their long rami start at the same level from a short calamus. The most familiar example of down is that of the ducks, in which it forms a regular inner padding under the ordinary contour-feathers.

There is a curious modification known as Powder-down. This is so called from the powder produced by the continuous disintegration of the numerous brush-like barbs and barbules, into which the barrel in constantly splitting as it grows without forming a principal shaft (Gadow). This powder-down grows in patches under the contour-feathers, generally on the breast and thighs, and it is most developed in the *Ardeidæ*, Herons and Bitterns. The purpose of it is quite unknown unless the usual assumption is correct that it has a cleansing effect on the feathers. It will be familiar to all as the curious powdery bloom seen on the face of the ordinary African Grey Parrot kept in cages as a talker. In India we meet with it not only in the *Ardeidæ* but in many of the birds of prey, especially the Harriers, and in the Frogmouths (*Podargus*). In the last named the powder-down attains its maximum development, being about 2 inches long, while it is interesting to remember that those familiar birds the Swallow-Shrikes (*Artamus*) are the only genus in the whole of the Passeres known to possess powder-down.

The third class of feathers are the Filo-plumes which consist of a short calamus and a very thin hair-like rachis with few or no rami. They are usually associated with contour feathers growing close to their bases and are seldom visible except in a few genera where they appear like hairs sticking out from amongst the contour-feathers. A marked example of this is found in the genus *Criniger* (as figured in *F. B. I.* 2nd ed., vol. i, p. 36.), but the feature is found almost throughout the Bulbuls (*Pycnonotidæ*). When a chicken is

plucked the long hair-like threads which remain sparsely distributed over the naked body are filo-plumes. Very occasionally they affect the appearance of a bird like contour-feathers, as for example in the Cormorants (*Phalacrocorax*). The white patches that appear on the neck and thighs of these birds in breeding plumage are due to the growth of specialized filo-plumes.

Finally it must be emphasized that no true hair is ever found on a bird. The eye-lashes found in the Ostriches and in the Hornbills (*Bucerotidæ*) and the various forms of rictal bristles found round the gape of many birds (most familiar to us in the case of the Flycatchers (*Muscicapidæ*) and the Nightjars (*Caprimulgidæ*)) are all modified forms of feathers, whether contour-feather or filo-plume, and have nothing to do with hairs which under the microscope are found to have an entirely different structure.

We have now pursued feathers through their classification into types. It is however also customary to classify them by generations, for the first clothing of newly hatched birds consisting in greater or less degree of some form of down-feather differs to some extent from the downs described above. For this reason the first generation of downy covering is distinguished by the name of Neossoptyles (νεοσσὸς a chick), while all other generations of feathers are called Teleoptyles (τέλεος mature).

A distinction is made in the Neossoptyles between the downs which precede the contour-feathers and the downs which precede the down-feathers; the former are called prepennæ and the latter are called preplumulæ. The prepennæ may themselves have two generations in which case they are distinguished as protoptyles in the first generation and the mesoptyles in the second generation. Once the Neossoptyles have given place by moult to the Teleoptyles the latter remain for life being renewed merely by moult in consequence of wear or to express the different plumages of age and season. They do not change in character as in the generations of the Neossoptyles.

The study of the Neossoptyles is still far from complete and it is most puzzling. The nestlings of some species develop both the protoptyles and the mesoptyles; in others the protoptyles are suppressed and the mesoptyles are degenerate; in others the teleoptyles may appear without the neossoptyles of either generation appearing, the nestling remaining at first absolutely naked; while on the other hand the nestling of the megapodes (*Megapodiidæ*) casts off the Neossoptyles before it leaves the egg and is hatched clothed in a plumage of the second generation. It is not necessary even that the sequence of generations should be the same on all parts of the same bird. The only Indian bird of which the sequence of these feathers has been worked out is the Common Sandgrouse (*Pterocles senegalensis*). Those who are interested will find a full summary of the changes as described by Dr. Claud B. Ticehurst in the *Bulletin of the British Ornithologists' Club*, vol. xlii, pp. 9–11.

The process by which a bird changes its feathers is well known to all under the name of Moult. The necessity of some system of replacing worn and damaged feathers is easy to understand for any

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one who has examined birds shot at the end of the breeding season. The wearing of the vanes of the feathers, which are subjected by every movement of the bird to a constant friction, the one against the other, is very great indeed. And this attrition is hastened by the action of wind and sand carried by wind. Some idea of its extent may be judged by the fact that in certain groups, as for instance the Buntings (*Emberizinæ*), the summer breeding plumage of the various species is attained simply by the wearing off of the fringes of the feathers which were assumed new the previous autumn. In the Buntings the body of the feather is one colour, a broad outer fringe another colour. In fresh plumage only the fringes are visible and their colour gives its tone to the bird. Between the autumn and the spring the fringes are worn away and the main colour of the feathers is visible instead, completely changing the appearance of the bird. By the end of the breeding season even this colour-pattern is threadbare, so that without some system of replacement the bird would be completely naked in a year or so. Extreme examples of wear occur at high elevations under the combined influence of high wind and desert conditions. There is in my collection a female of Güldenstädt's Redstart (*Phoenicurus e. grandis*) which I shot at the nest near the summit of the Baralacha Pass at 15,000 ft. in Lahul. In this bird the feathers are so terribly worn that only the centres of the vanes persist and what should be a warm brown bird appears a ragged streaky blue-grey hardly recognizable as to species. The flight feathers, the rectrices and remiges, wear in a corresponding manner to the body feathers, and in the course of a single year this wear may shorten them by several millimetres in the case of a small passerine bird. Leaving aside the consequence of accidental breakage, and this is common, normal wear would soon render a bird flightless unless the quills were annually replaced.

In addition to normal wear and accidental breakage there is a third less important factor to be considered, namely the damage done by parasites. There are certain biting-lice (*Mallophaga*) which actually feed on the vane of feathers. The sum total of the damage done by these lice is not usually noticeable, though it may be responsible for much of what we usually consider normal wear; but that it may be considerable is shown by the case of the common Pariah Kite (*Milvus migrans govinda*), one of our Indian birds to whom its feathers must be of the utmost importance for its wonderful power of flight. I have repeatedly seen these birds with the vane of their tail-feathers so eaten away that little but the shafts remained, the tail a mere skeleton of itself.

The faculty of replacement of feathers lies in the unlimited reproductive power of the follicle from which the feather grows. When one generation of feather is complete the dermal pulp from which the growing feather is nourished and the malpighian cells which gave its structure lie dormant in the retracted follicle until they are awoken to renewed growth by the season of moult. The accidental loss of a feather is often sufficient to awake and stimulate the appropriate follicle, an important attribute when the life of a bird may depend on the undiminished power of flight. The effect of the loss of a single flight feather is well known to all Indian

falconers who are accustomed to repair such damage by the process of 'imping' or temporary grafting on the corresponding part of a duplicate feather to the remaining base of that broken. Once awoken the active follicle pushes out the old feather and produces a new one in its place. The process of the growth of a feather is too long to be described here but it will be found at full length in Newton's *Dictionary of Birds*, pp. 245–248. What exactly starts the follicle to activity in the case of normal moult is not known, but it may be only a seasonal rhythm.

As a general rule it may be stated that all species undergo a complete moult in the autumn after the breeding season is over. That the act of incubating a clutch of eggs and feeding and brooding the nestlings is one of the severest trials to which the feathers of a bird are subjected is easily seen when we consider merely one aspect of the damage, that to the breast feathers. If a brooding bird is examined it will be found to be naked of feathers over a very large area of the under parts where the skin has become inflamed and internally full of moisture. This occurs in both sexes where both sexes incubate.

Yet it is after breeding that birds are in as great need of perfect feathering as at any time of the year, for with the autumn comes in a large number of species the autumn migration, and for those that do not migrate the rigours of winter have to be faced.

A complete autumn moult then is almost universal in adult birds, and it is very general also in the young birds of the year which moult from the juvenile neossoptyle dress to their first teleoptyle plumage. In many species there is in addition a spring moult, though this is usually not extended to the quills of the wing and tail. In a few species there is even a third moult in the year. There is a great deal of variety in the sequence of the moults and plumages amongst birds, and uniformity is not found even amongst the members of the same family and genera; nor does the immature bird necessarily moult the same feathers as does its mature form at the same season. There is however a general uniformity in the changes undergone by the individuals of a species. Moult is not haphazard; all individuals undergo the series of moults customary in their age and species, however details may vary between species.

It may be remarked also that moult is not entirely confined to the feathers. In a very few species it has been observed to take place in the horny covering of the beak, though none of these instances are recorded of any Indian species. Observers in India may however be advised to pay attention to the comb of the Comb-Duck (*Sarcidiornis melanotus*), or to see whether our breeding Pelicans develop and shed a curious horny excrescence on the beak similar to that recorded in the White Pelican of Northern America. Larks, Pipits, Wagtails and Grouse are known to moult their claws and the inference is that most birds do so.

The colour of a feather is produced in one of three ways: by actual pigment, by physical structure, or by a combination of physical structure with an underlying basis of pigment. The brightness of colouration found amongst birds like that of insects is considered to have some connection with the fact that birds and

insects are the creatures of intensest life, that the brightness of their colours as represented by pigment are due to the waste-products of an intense life. However this may be we must consider the three methods by which colour actually appears in a feather visible to the naked eye.

The simplest to understand is that of pigment. In such cases the actual colour is present in the feather visible to the eye whether as a solution suffused throughout the various parts, in the form of little particles distributed in or amongst the cells of the organism. Such a colour does not vary under any position of the eye or light, or even under transmitted light. Black, red and brown feathers always belong to this group, as do most cases of yellow and orange. Blue and white are never due to pigment, and green only in the case of the Plantain-eaters (*Musophagidæ*), an African family whose feathers are not only found to contain Turocoverdin (the name given to their special green pigment) but also a curious red pigment, Turacin, confined to them and found only in their wing-feathers. Turacin is so easily soluble in water that when the birds bathe or are wet with rain the red colour runs out of the feathers into the water; it is however rapidly replaced.

Colour due to structure depends for its existence on the theory of light. If the yellow pectoral tuft of a Sunbird is examined microscopically it will be found to contain no pigment but its surface is divided into a series of ridges and furrows. The width of a ridge is less than 0·0007 mm. and of a furrow about 0·002 mm. so that the surface of the feather may be said to consist of a system of narrow gratings which isolate the yellow rays of light and give the appearance of a yellow feather.

White is never due to pigment. The whole substance of a white feather is colourless, but there are an innumerable number of interstices beween the air cells in its substance. This texture forms a fine net work which diffracts and reflects the light and produces the effect which we call white.

Colour due to structure is usually found in combination with colour due to pigment, that is to say it is very common to find pigment in the feather overlaid with special structure of a superimposed colourless part, the result being apparent to the eye in a colour different to that of the pigment actually present. Such a feather when held up against the light appears of the colour of the underlying pigment, and if the surface is scratched or crushed only the pigmentary colour remains.

Violet and blue always belong to this class, green usually, and occasionally yellow. Feathers of this type do not change their colour with the incidence of the light or the movement of the spectator, that is to say their structural colours are objective.

There are however certain subjective structural colours, which do change according to the position of the light and the eye of the observer. These owe their metallic or prismatic colour to a transparent colourless layer which acts like a series of prisms on a black or blackish-brown pigment below. All such feathers appear black when their surface is parallel to the rays of light in the same level with the eye and the light. As the position of the eye and the light

change the colour of the feather changes but always in the order of the colours of the spectrum, though not necessarily all the colours will appear.

The three types of colouration, to take an example, are found together in one of our commonest Indian birds, the Purple Sunbird (*Cinnyris asiatica*). The metallic portions of the plumage are due to pigment overlaid with special prismatic structure, the unmetallic black and brown and the red pectoral tufts are due to pigment, while the yellow pectoral tufts are due to structure alone. The whole effect is heightened by a surface gloss due to the polish of the horny surface of the feather. As the feathers wear with age the gloss of all parts of the plumage is affected, though such wear does not affect the colour of the feathers except in so far as colour is due to structure. In fact it is permissible to believe that the darker pigments definitely contribute to the durability of a feather. Any one who has shot many of the waders will be familiar with their tertiary plumes in which a dark central area sends dark branches out to the edges of the feather, each patch being separated by white or grey. In worn plumage these white patches wear away leaving the dark areas so that the feather appears deeply serrated.

As is to be expected there is a certain amount of abnormality in the colour of feathers, though abnormality of shape and growth is seldom found and never to a remarkable degree. The most familiar examples of this are known as albinism, melanism, xanthochroism, and erythrism, named according to the deviation of colour.

Albinism is an abnormal absence of colour so that the part affected appears dead white. It may be total affecting not only the feathers but even the beak, eyes and legs, or it may be partial either in extent or degree. It is due to the absence of the usual dark pigment or even to the absence of colour-producing structure whether this be due at birth to the omission of some hereditary factor or developed later in life as the result of some abnormal disturbance of the system. It is most familiar to us in India in the case of the Common House Crow (*Corvus splendens*). Complete albinos of this bird are not very common but most of us have seen partial albinos, whether the specimen be piebald, a mixture of white patches amongst the normal plumage, or the whole colour be pitched in a lower tone, black replaced by brown, ashy-grey by cream colour. Albinism is undoubtedly most common in resident birds of a sedentary nature so that its usual cause may be inbreeding. When single abnormal white feathers occur in a bird they are generally due to individual damage to that feather during development.

Melanism is the exact opposite of albinism and is due to a superabundance of dark pigment. It is rather rarer than albinism and I can think of no familar example amongst Indian birds though we have all heard of Black Panthers. Xanthochroism when the abnormal feathers are yellow and Erythrism where they are red or reddish are much less common in wild birds than in captives. The former is most frequently found in the Parrakeets where green feathers are yellow, probably as the result of some fault in superstructure. I once met an immature Green Bee-eater (*Merops orientalis*) in which the beautiful green of the normal plumage was

replaced by a delicate canary yellow. Xanthochroism is not however confined to green feathers. The wonderful scarlet males of *Hæmatospiza sipahi*, the Scarlet Finch of the Eastern Himalayas, become orange-yellow in captivity. One that was known to me in captivity in England escaped and remained at large for several months. The increased functional activity that resulted was doubtless responsible for the fact that the bird moulted while at liberty into the correct scarlet colour but when it was recaptured this again gave place to orange-yellow at the next moult.

Erythrism is certainly scarcer than Xanthochroism as an abnormal variation in wild birds. But on the other hand in one or two species it appears to occur with a frequency that amounts almost to a normal variation equivalent to dimorphism. The 'hepatic' variety of certain Cukoos and the chestnut phases of the Scops Owls of the *Otus sunnia* group immediately occur to the mind in this connection; while that gaudy-looking Barbet, *Cyanops asiatica rubescens*, in which crimson irregularly takes the place of the green of the typical form may perhaps be only another manifestation of the same thing.

An interesting point in connection with all these abnormalities of feather-colouring is that any actual patterns on a feather usually persist in spite of the abnormality, even though they may be reduced to a mere ghost visible only in certain lights.

The consideration of that aspect of feathers which relates to the colouration of the bird as a whole, that is the significance of the various types of plumage, must be delayed to a subsequent chapter. Here it is sufficient to remark that the colouration of individual feathers is based on two main types, the longitudinally streaked feather and the transversely barred. The former is probably due to a greater richness of pigment nearer the centre of the growth of the feather; the latter is believed to be related to a diurnal fluctuation of blood-pressure, as Thompson calls it 'a ripple mark of growth', resulting in varying deposits of pigment in the growing feather. That growth and the deposit of pigment take place transversely in a feather is familiar to most of us from the 'hunger-marks' or 'fault bars' so often visible on the plumage of a bird which has moulted in captivity, which show up almost as a cut from a knife across the surface of the feather.

Hitherto we have been considering the aspects of a feather in relation to the parent bird which produced it. But no account of feathers would be complete without some mention of the use of them made normally by birds after primary functions have ceased. It is well known that ducks and geese pluck their own feathers, especially down, from their underparts to use them as material for their nests. No softer or warmer nest material could be imagined, and the fact is recognized by numberless other birds which collect fallen feathers of any species as lining for their nests. It is customary to quote the case of the Long-tailed Tit of England in one of whose nests Macgillivray counted 2,379 feathers, but in India we have only to look for the nest of the familiar Himalayan Red-headed Tit (*Ægithaliscus concinnus*) to reach a similar total, while less industrious gleaning is practised by many other species.

Less well-known is the fact that the grebes (*Podicipidæ*) are accustomed to swallow many of their own feathers, apparently as an aid to digestion in place of the grit and stones used by most birds for the purpose.

Finally the Bower-birds of Australia, allied to the Birds of Paradise, have the unique habit of using brightly coloured feathers, as well as shells and stones and flowers, definitely as ornaments to the 'bowers' which they construct as playing grounds. This is a use which we cannot parallel in India.

(*To be continued.*)

SCIENTIFIC RESULTS FROM THE MAMMAL SURVEY
No. XLVIII

INDIAN SHREWS

BY

MRS. HELEN M. LINDSAY, M.A., B.SC.

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The Indian shrews have been described from time to time and many names applied to them, but only the collections made by the Indian Mammal Survey have brought such a mass of material together from all over the Peninsula and have thus made possible a comparative study of the whole group. Amongst the early writers on these shrews Blyth in 1855 and Anderson in 1877 have worked out several species in detail, but in many cases they have had only one single specimen of each for investigation. Hodgson in 1845 working in Sikkim had no references at hand and no types for comparison. The still earlier writers too, like Is. Geoffroy, wrote without knowledge of the country and worked on isolated specimens. Thus confusion in the nomenclature of the Indian shrews has been inevitable. This paper is an attempt to systematize the group from a careful study of all the old authorities and literature on the subject along with examination of the splendid series of specimens collected by the Survey from completely representative areas of India. The results obtained are another tribute to the great value of a long series of specimens, just as were the squirrels from Chindwin described by Oldfield Thomas and R. C. Wroughton in Scientific Results No. XII, published in *J.B.N.H.S.* of January 1916, and the Rats of India, Burma and Ceylon described by M. A. C. Hinton in Scientific Results No. XVIII, in *J.B.N.H.S.* of December 1918.

There have been several changes in the course of time in the name of the genus itself but systematists have now decided that the name *Suncus* must stand. In 1924 Cabrera published a note in the *Journal of Mammalogy*, vol. v, p. 131, revising the nomenclature of this group of the Insectivora. He found that 'the name *Pachyura*, generally used for a genus of white-toothed shrews, is unfortunately antedated by *Suncus*, established in 1832 by Hemprich and Ehrenberg (Symbolæ Physicæ, 11. K), the genotype being *Suncus sacer*= *Sorex crassicaudatus*, Lichtenstein. Cabrera in his *Genera Mammalium*, p. 142, thus gives the synonymy of the generic name :—

1792. *Sorex* Kerr, Anim. Kingd., p. 207.
1832. *Crocidura* Wagler, Isis, p. 275.
1832. *Suncus* Ehrenberg, Symb. Phys., dec. 2 K.

1839. *Pachyura* de Selys Longchamps, Etud. Micromamm., p. 32.

1855. *Paradoxodon* Wagner. Schreber Säug., Suppl., p. 805.

1897. *Pterodus* Schulze, Helios Abhandl. Vortr. Gesamm. Naturwis., xiv, p. 90.

The oldest name of *Sorex* is now confined to European red-toothed shrews, and that of *Crocidura* to creatures with 16 upper teeth instead of 18 as in the genus under review. Thus *Suncus* must be used as the next oldest on the list.

Blanford in his *Mammalia*, p. 232, notes that 'the species of this 'genus are very variable and difficult to discriminate. One principal 'reason, besides variability, for the large number of nominal 'species in this genus lies in the fact that it is frequently impossible 'by external characters, and even by an examination of the teeth, to 'ascertain whether individuals are adult. The teeth are fully 'developed and the animals breed freely long before they attain 'their full growth. Most of the sutures of the skull too are anchy-'losed at an early age, the premaxillary suture being closed in 'shrews at birth or very soon after.' Here again is proved the value of a long series of specimens which allow the general characters of the species to be noted and it is on these general lines that the present distribution of species has been made. In all cases the old papers on the group have been consulted. It has been found impossible to retain the old specific name of *murinus* as the confusion surrounding it was too great. Then, too, the name of *cæruleus* has been taken for the representative stock of the areas of the Indian plains, and local differences are marked by subspecific names. The establishment of a network of railways, and the enormous growth of intercommunication between areas widely separated tend to obliterate differences in such animals as shrews that are so easily carried. In this collection, for example, specimens of *Suncus cæruleus giganteus* were taken at Salsette, Bombay, though the typical locality is Darbhanga district in Behar, and also specimens of *Suncus cæruleus cæruleus* were taken in North Ceylon, both cases no doubt due to introduction of the creatures in consignments of merchandise. Mr. W. W. A. Philips in *Spolia Zeylanica*, vol. xiii, part. 2, p. 189, has recorded specimens from Colombo as *Pachyura cæruleus* which agree in every particular with the Survey specimens of *Suncus cæruleus giganteus* and he also has suggested that 'this species may have come over from India or elsewhere in ships.' In the work of determining these shrews which number almost 1,000, invaluable help has been given by Mr. T.B. Fry and also by the measurements so painstakingly made by the late Mr. R. C. Wroughton.

Synopsis of the Species of Suncus

A. *Large size.*

I. *Habitat on Plains.*

a. *Cæruleus* group.

*a*1. *colour pale ashy.*

1. *cæruleus*—averaging H. & B. 130 mm., H. F. 19 mm. Habitat, Jumna and Ganges Plains.

2. *giganteus*—averaging H. & B. 140 mm. H. F. 26 mm. Habitat: Darbhanga.

b1. colour all shades from fawn to ashy-brown.

1. *sindensis*—averaging H. & B. 116 mm., H.F. 18 mm., claws long and hooked, neutral grey colour. Habitat: Kathiawar and Sind desert areas.
2. *fulvocinereus*—averaging H. & B. 137 mm., H.F. 22 mm., claws long and pointed, fur brownish-grey, soft and long. Habitat: Assam Valleys.
3. *blanfordi*—averaging H. & B. 108 mm., H. F. 21 mm., fur very short and close. Habitat: Western Ghauts and Deccan.
4. *kandianus*—averaging H. & B. 137 mm., H.F., 19 mm., fur short. Habitat: Kandy, Ceylon.
5. *tytleri*—averaging H. & B. 113 mm., H.F. 19 mm., fur thick, soft and long. Habitat: Western Himalayas and Siwaliks.

b. fuliginous colour.

1. *viridescens*—averaging H. & B. 123 mm., H.F. 19 mm., lower parts distinctly greenish-yellow. Habitat: Trivandrum.
2. *fuliginosus*—averaging H. & B. 140 mm., H.F. 20 mm., lower parts scarcely paler than the back. Habitat: Burma.

II. *Habitat on Hills.*

a. uniform brown colour with dark feet.

1. *soccatus*—averaging H. & B. 122 mm., H. F. 20 mm., feet clad to the nails, fur soft and long, tail compressed and tufted at tip. Habitat: Darjeeling District.
2. *saturatior*—averaging H. & B. 117 mm., H.F. 20 mm., feet bare, fur close and short, very dark, tail cylindrical, tapering, no tuft at tip. Habitat: Sikkim.

b. brown with lighter ventral surface.

1. *griffithi*—averaging H. & B. 123 mm., H.F. 19 mm., soft, long fur, claws strong and short. Habitat: Assam Hills.
2. *niger*—averaging H. & B. 97 mm., tail 68 mm., soft, fine, short fur. Habitat: Nilgiri Hills.
3. *niger malabaricus*—averaging H. & B. 121, tail 76, Habitat: Coorg.
4. *montanus*—averaging H. & B. 93, tail 62, tail tetragonal, fur very soft and dark. Habitat: Ceylon Mountains.

B. *Small size.*

I. *Habitat on Plains*—fawn coloured.

a. pale underneath.

1. *subfulvus*—averaging H. & B. 70, H. F. 10·5, colour pale fawn. Habitat: Kathiawar and Sind.
2. *nitidofulvus*—averaging H. & B., 48., H.F. 9, colour shining brown. Habitat: Chaibassa (Bihar and Orissa).
3. *leucogenys*—averaging H. & B. 72, H.F. 11, colour light cinnamon brown, dirty white below. Habitat: Rajputana.

b. dark grey underneath.

1. *stoliczkanus*—averaging H. & B. 73, H. F. 12, colour dull brown. Habitat : Gwalior and Central India.

II. *Habitat on Hills*—brown coloured.

a. pale beneath.

1. *micronyx*—averaging H. & B. 41., H. F. 8., buffy-brown on back, grey below. Habitat : Masuri.
2. *perrotteti*—averaging H. & B. 48 mm., H. F. 8 mm., reddish brown, paler below. Habitat : Nilghiris and S. India.

b. dark beneath sometimes with silvery sheen.

1. *nudipes*—averaging H. & B. 48 mm., H.F. 8·5 mm., uniform brown, naked feet and large ears. Habitat : Burma and Assam Hills.
2. *pygmaeoides*—averaging H. & B. 46 mm., H. F. 9 mm., rich rusty brown. Habitat : E. Himalayan slopes.
3. *dayi*—averaging H. & B. 71 mm., H.F. 15 mm., dark brown. Habitat : Madras Hills.

1. *Suncus cæruleus cæruleus.*

1832. *Sorex myosurus*—Pallas, Gray and Hardwicke. Ill. Ind. Zool. i, pl. ix.
1843. *Sorex murinus*—Gray, List Mamm. Brit. Mus., p. 78.
1792. *Sorex cæruleus*—Kerr. Anim. Kingdom, p. 207.

This represents *Sorex cæruleus*, Kerr, of 1792 and *Sorex myosurus* Pallas illustrated in Gray and Hardwicke's Illust. of Ind. Zool. i, pl. ix. It is thus the oldest of the groups of this genus since the name *Sorex murinus* of Linnaeus (1766) has to be dismissed (according to Cabrera in Genera Mamm. p. 144) as indeterminable.

Distribution. In the Survey, specimens belonging to this species were obtained from Gwalior (46); Central Provinces (37); Nimar (4); Bihar and Orissa with Bengal (44); Ceylon (9). These areas cover the countries drained by the Jumna and Ganges Rivers. The finding of the nine specimens from the Northern province of Ceylon is probably due to the carriage of such animals in trading boats.

Colour. Bluish-grey, washed with fawn, pale clear grey or buffy below. Tail, ears, feet and snout flesh-coloured. An accurate representation of this creature is given by Gray and Hardwicke as *Sorex myosurus*, Pallas.

Dimensions. Specimen No. 1520 from Chanda, Central Provinces, may be accepted as typical, as its measurements are exactly those of the average of 10 specimens. Head and Body : ♂ 131, tail 77, H.F. 19, ear 14.

2. *Suncus cæruleus giganteus.*

1837. *Sorex giganteus.* Is. Geoff. Voy. Belang. p. 117.
1800. *Sorex cærulescens.* Shaw. Gen. Zool. i. p. 533.
1796. *Sorex pilorides.* Shaw. Mus. Lever. ii. p. 31.

As the 31 specimens from Darbhanga District and those taken in the east of Nepal and in Midnapore District were larger than those of the other Plains areas it seemed advisable to record

these under a subspecific heading as *Suncus cæruleus giganteus.* This is the *Sorex cærulescens* of Shaw (1800) and Blyth, and the *Sorex giganteus* of Is. Geoff. (1837). Blanford describes it as bluish-grey, paler below, the fur sometimes with ferruginous brown tips. Specimens vary from true bluish-grey to rufous fawn tint above, grey below. Skin of the snout, ears, feet and tail flesh-coloured, hairs on the feet and tail white or nearly white.

Dimensions : Specimen No. 511 from Bahgownie, Darbhanga, is typical of this group. H. & B. 140., Tl. 95, H.F. 24, ear 15. The largest received measured H. & B. 157, Tl. 95, H.F. 24, ear 15. Blanford notes that the tail varies in length considerably.

3. *Suncus cæruleus fulvocinereus.*

1877. *Crocidura (P.) fulvocinerea.* Anderson. *J.A.S.B.*, vol. xlvi, p. 263.

The fine series of 66 specimens obtained by the Survey in Kamrup, Assam, illustrates well the separation by Anderson in 1877 of the group which he called *Crocidura (P.) fulvocinerea,* described in the *J.A.S.B.*, vol. xlvi, p. 263. His description is borne out by these specimens. The snout is long and pointed ; feet well developed and moderately haired; tail swollen at the base, rather long and densely haired. The claws are long and pointed (not so hooked as in the next group of *S. c. sindensis*).

Colour : Fur dark slaty in the basal portions, but broadly tipped with fawn producing a brownish-grey mixed with tawny. There is a rusty tinge on the head. Underparts more greyish.

Dimensions : In size this group resembles *S.c. giganteus* but the feet are not so large. The average measurements of 10 specimens gave H.B. 137·4, tail 81·9, hindfoot 22·3, ear 14. Specimen No. 1225 from Angarakhata, N. Kamrup, gives head and body 142, tail 83, hindfoot 23, ear 15.

Distribution : The valley of Assam whence at Gauhati Anderson got his types No. 229 SS in Cat. Mamm. Ind. Mus.

4. *Suncus cæruleus sindensis.*

1877. *Crocidura (P.) sindensis.* Anderson, *J.A.S.B.*, vol. xlvi, p. 266.

Anderson (1877) describes this group as *Crocidura (P.) sindensis.* He says that it has 'snout moderately long and pointed ; ears 'full and rounded ; sparsely clad, the margins and flaps with longish, 'somewhat stiff hairs ; feet slender and toes rather long. Fur 'moderately long, soft and glossy ; neutral grey with a flush of 'umber, very pale in some cases ; underparts neutral grey with a 'silvery sheen. Feet yellowish, sparsely clad with whitish hairs ; 'claws rather long and hooked. Tail pale coloured, ringed, sparsely 'clad with white hairs, a few long ones interspersed.'

Specimen No. 2019 from Kudia, Kathiawar, may be taken as typical in its measurements. Head and body 115, tail 65, hindfoot 18, ear 12.

Anderson gives the type as 229 vv of Cat. Mamm. Ind. Mus. and records this group as 'inhabiting (Sindh) Karachi'. The specimens in the Survey collections came from Kathiawar (46), Rajputana (19),

Cutch (9). It may be accepted as the western representative of the *cæruleus* species, inhabiting desert areas.

5. *Suncus cæruleus blanfordi.*

1877. *Crocidura* (*P.*) *blanfordi.* Anderson, *J.A.S.B.*, vol. xlvi, p. 269.

This group is found in the Western Ghauts and Deccan area. In the Survey collection specimens came from Khandesh 3; Poona 5; Dharwar 16; Kanara 4; Mysore 12; Satara 10–50 in all. Anderson describes this as *Crocidura* (*P.*) *blanfordi* in the *J.A.S.B.*, vol. xlvi, p. 269.

Colour: The fur is very short, dense and mole-like, greyish at the base, the remainder deep fawn or brown showing a speckled appearance or grizzle; underparts greyish-brown with a silver sheen. The gradation of colour is marked in the group, some being pale, others, especially the younger ones, darker and there is one very grey specimen. They resemble *S. c. sindensis* but have larger feet and ears. The tail is paler than the feet.

Dimensions: Specimen No. XLV from Poona has measurements nearest the averge of 10 specimens and may thus be taken as typical. Head and body 108; tail 75; hindfoot 21; ear 15. Anderson gives the measurements of his type, which came from Khandalla on the Western Ghauts, as: head and body 107; tail 60; hindfoot 18. This must have been a young specimen. It is No. 231 gg of the Cat. Mamm. Ind. Mus.

6. *Suncus cæruleus kandianus.*

1852. *Sorex kandianus.* Kelaart. Prod. Faun. Zeyl. p. 30.

In 1852 Dr. Kelaart described a shrew from Ceylon which he called *Sorex kandianus.* A series of 19 specimens from Kandy was got by the Survey and these, while bearing out Kelaart's points, agree so closely with others of the *cæruleus* group that it has been thought better to call these creatures *Suncus cæruleus kandianus.* The fur is short but not so close as in *S. c. blanfordi*, ashy brown with ferruginous smear on the upper surface; paler beneath. The whole set shows a heavily built creature. Specimen No. 912 from Kandy, C.P., shows measurements head and body 134; tail 79·5; hindfoot 19; ear 13, which is almost identical with those of *S. c. fulvocinereus* from Assam.

Kelaart gives the measurements of the type specimen, No. 231 ff. of Cat. Mamm. Ind. Mus., as head and body 118; tail 50; probably a young specimen. The colour varies from brown to grey through all shades of these, though all the specimens were taken at the one place and at the same time of the year.

7. *Suncus cæruleus tytleri.*

1859. *Sorex tytleri*, Blyth, *J.A.S.B.*, vol. xxviii, p. 285.

In the *J.A.S.B.*, vol. xxviii, p. 285, Blyth thus describes the species 'a remarkable species from Dehra Dun of a light rufescent 'sandy brown colour, unusually well clad even on the feet and tail. 'Fur of the body dusky for the basal two-thirds or more and tipped 'with the hue described; upper parts being more rufescent; the

lower slightly paler; form unusually robust.' The splendid series of specimens collected by the Survey verifies and amplifies the above description. Specimens number 70 from Kumaon, 19 from Kangra, 15 from the Salt Range, 5 from Chamba, 7 from Murree, 8 from West Nepal and 2 from Kashmir—126 in all. These all agree in the main with the description of this species, the shade of colour varying slightly with the altitude at which the specimen was obtained, being a little darker in those from 6,000′, than in those from 2,000′ or 800′, but the proportions and general character remain unaltered. All specimens show a rufescent patch on the throat extending between the forearms; the tail is the same colour as the body and the feet are a shade lighter than the tail. The feet are slender and the toes long, the claws long and hooked. This group represents the Western Himalaya area where the rainfall is from 40″–50″ annually, and includes the lower slopes of the Himalayas called the Terai and the Siwaliks. There is no record of the location of the type specimen.

Dimensions: A typical male from Kangra, 2,000′ (No. 2913) measures: head and body 114; tail 75; hindfoot 19; ear 13. One from Rohilkund, 800′ (No. 4552) measures: head and body 124; tail 80; hindfoot 20; ear 12. One from Kashmir (Arpul Valley, 6,300′) collected by Major Stockley, No. S. M. 23, measures: head and body 115; tail 80; hindfoot 20; ear 12.

As the affinity of this set with the *cæruleus* group is so close this has been called *Suncus cæruleus tytleri.*

8. *Suncus soccatus.* Hodgson, 1845. *A.M.N.H.*, vol. xv, p. 135.

1855. *Sorex heterodon*, Blyth., *J.A.S.B.*, vol. xxiv, p. 31.

Hodgson describes this group (*A.M.N.H.*, vol. xv, p. 270) as being distinguished from other Sikkim and Eastern Himalayan species by its 'feet being clad in fur down to the nails, by the 'depressed head and tumid bulging cheeks,' which give the face a squat appearance compared with the long, attenuated snout of *S. c. fulvocinereus.* He describes the colour as 'uniform sordid or 'brownish slaty blue extending to the clad extremities.' Blyth in *J.A.S.B.*, vol. xxiv, p. 30 states that the tail is compressed toward the tip, which is furnished with a pencil tuft of stiffish hairs.

The survey obtained 10 specimens of this group in Sikkim; 96 from Darjiling; 38 from Kalimpong and 70 from Bhutan Duars, thus 214 in all from the area around Darjiling.

All the specimens agree with the descriptions given by Hodgson and Blyth. These creatures are distinctly darker than those of *S. c. tytleri* and have the lower surface the same colour as the back, no difference of the tint under the chin.

Measurements.—Typical are No. 5807 female from Rongli, Sikkim, 2799′—head and body 116; tail 73; hindfoot 19; ear 12, mammæ 6. A male from Pashok, Darjiling, 3,500′, No. 333, measures: H. & B. 122; tail 82; hindfoot 21; ear 12; while a female, No. 463, from the same place has head and body 117; tail 74; hindfoot 20; ear 11; a male from Hasimara, Bhutan Duars, 600′, No. 1030, has head and body 124; tail 80; hindfoot 22; ear 12. The area is on the belt that receives fairly heavy rainfall 75″–100″ annually and is

well wooded. Specimen No. 79, 11, 21, 472 B. M. is also typical of this group.

9. *Suncus saturatior.* Hodgs. 1856, *A.M.N.H.*, vol. xvi, p. 110.

Hodgson has described this species in *A.M.N.H.*, vol. xvi, p. 110. Its colour is deep brown with very slight rufescent shade; fur short and mole-like; tail cylindrical, long, gradually tapering; snout long, regularly attenuated; ears moderate. Only two specimens were obtained. One was given by Colonel Bailey from Gangtok 6,000′. The other was got by Crump, No. 5687, female, in Gangtok, Sikkim, 6,000′. The hindfeet and legs are not clothed with hair as in *Suncus soccatus*, the colour is much darker than in that species and the fur shorter and closer. No. 5687 measured: head and body 117; tail 72; hindfoot 20; ear 12. There is no pencil tuft at the end of the tail as in *S. soccatus*. The type specimen is B.M. No. 79, 11, 21, 474.

10. *Suncus griffithi.* Horsfield 1851. Cat. p. 134.

1877. *Crocidura (P.) blythi.* Anderson, 1877, *J.A.S.B.* vol. xlvi, p. 264.

This is the name that includes all the Assam Hill specimens of which 23 were taken by the Survey.

Anderson in *J.A.S.B.*, vol. xlvi, p. 264 (1877) describes this group under *Crocidura (P.) blythi*, but as the older name is *Sorex griffithi* (1863) that must now stand. It is described by Anderson as 'snout pointed and rather long; feet moderately large; fore-limb with long hairs to the wrist, larger than those of the hind limb; claws strong but short; fur soft and rather long; colour a rich rusty dark brown with a golden sheen in certain lights, under surface greyer, with a rufescent flush below the chin.' Some are darker than others.

Dimensions: Specimen No. 964 taken at Shangtung, Jaintia Hills at 4,000′ may be taken as typical female—head and body 128; tail 69; hindfoot 19; ear 12.

There has been considerable confusion regarding the provenance of the type specimen of this species but Blyth's explanation seems so reasonable that this shrew had been inadvertently entered as from Afghanistan, rather than Assam, and since he himself saw a specimen in the possession of Dr. Griffith which undoubtedly came from Cherrapunji, Assam, it is safe to assume that Blyth is right and so *griffithi* denotes the Hill species of Assam. The type is B.M. No. 79, 11, 21, 471 and another specimen is B.M. No. 91, 10, 7, 54.

11. *Suncus niger*, Elliot. Horsfield. Cat. Mamm. 1851, p. 135.

This species is the shrew of the Nilgiri and Palni Hill areas of 6,000′ altitude. Horsfield describes it in his Catalogue, p. 135, as 'blackish brown with a rufescent shade on the upper parts

abdomen greyish. Snout greatly attenuated.' The series got by the Survey comprises 26 from the Nilgiris and 20 from the Palni Hills, the latter being much darker than the former, no doubt due to seasonal variation as the dark ones were taken in the winter months. They all agree in size, the soft fine texture of the fur and the very pronounced thin snout. The feet are slender with long toes and fine claws. On the dark specimens the underparts are very little paler than the backs, while in the Nilgiri ones, taken in July, the bellies are distinctly grey with a silvery sheen on some, others showing both tints where the fur is changing.

Dimensions.—Specimen No. 22 from Kodaikanal 7,000′ is a typical male. Head and body 97 ; tail 68 ; hindfoot 17 ; ear 12. The type specimen is No. 147 of Horsfield's Cat. Mamm.

12. *Suncus niger malabaricus.* subsp. nov.

The Survey collected 21 specimens from Coorg and 4 from Cochin all at altitudes about 3,000′. As the series differs in size considerably from *Suncus niger* of the Nilgiris while retaining the characteristic dark soft fur and attenuated snout of that species, it is thought better to denote such shrews by a subspecific name and thus these have been called *Suncus niger malabaricus*. This shrew is consistently of larger build than the Nilgiri one. Thus specimen No. 2437 from Virajpet, South Coorg, 3000′, measures : head and body 118 ; tail 75 ; hindfoot 19 ; ear 13 ; An average of 10 male specimens gives head and body 121·3 ; tail 76 ; hindfoot 19 ; ear 13.

13. *Suncus viridescens*, Blyth. *J.A.S.B.*, vol. xxviii, 1859, p. 285.

Eight specimens of this species were obtained by the Survey, 3 in Madura and 5 in Trivandrum. They are distinguished by their fur (which, as Blyth notes, is unusually short and close) and their size and build from the other South Indian shrews. The snout is not slender and so drawn out as in *Suncus niger malabaricus*. Blyth describes this shrew in *J.A.S.B.*, vol. xxviii, p. 285 as having 'colour very dark ; fuliginous on the face to behind the ears and the upper parts slightly, the lower very conspicuously tipped with yellowish which imparts a dingy, greenish aspect, whence the name.' This has been reported as the common species of Southern Malabar.

Dimensions : Specimen No. 11 from Trivandrum, female, may be taken as typical. Head and body 125 ; tail 70 ; hindfoot 20 ; ear 15. This shrew was 'moulting' and shows the two shades of dark and lighter greeny grey very plainly. The type specimens are Nos. 231 cc, dd of Cat. Mamm. Ind. Mus., which are Nos. 246 g, h of Blyth's Catalogue.

14. *Suncus montanus*, Kelaart. Prod. Faun. Zeyl., 1852, p. 31.

Six specimens were obtained of this species in Ceylon, all above 5,000′, and in an area with a rainfall over 100″. This is the darkest of all the shrews in the collection, the only ones approaching them in depth of colour being *Suncus saturatior* from Sikkim and those from the Nilgiris, *Suncus niger*, in winter coat. This set was taken in end March and April before the shed of winter coat begins.

Kelaart, who named this species, thus describes it in Prod. Faun. Zeyl., p. 31: 'Fur above sooty black without any ferruginous smear; 'beneath lighter; claws short; ears large, round, naked. Tail 'tetragonal, shorter than head and body, covered with short, dusky brown hairs.' Kelaart states that no sebaceous glands are visible, but these specimens plainly show the glands. The average measurements of these six shrews give: head and body 86; tail 61; hindfoot 17; ear 10·5. Specimen No. 1024 male, from Pattipola, C. P. Ceylon 6,210′, shows head and body 93; tail 62·5; hindfoot 17·5; ear 11. Kelaart measured a shrew from Pedrotellagalla (8,000′) as H.B. 94; tail 56; H. F. 17.

15. *Suncus fuliginosus*, Blyth. 1855, *A.M.N.H.* 2, vol. xvii, p. 22.

Blyth named a shrew received from Pegu as *Sorex fuliginosus* in *J.A.S.B.*, vol. xxiv, p. 326. He describes it as 'having the soles of 'the feet bare to the heel, the tail with small fine hairs scattered upon 'it, the fur dense, porrect, somewhat velvety; dark slaty at the base, 'the rest fuliginous brown with inconspicuous dull hoary tips; 'beneath scarcely (if at all) paler. Length of adult female $5\frac{1}{2}$ 'inches (137 mm.); tail $2\frac{1}{4}$ inches (56 mm.); foot $\frac{5}{8}$ inches (16 mm.).'

The Survey has from Pegu 8 specimens, from Mergui 4 specimens and from Mt. Popa, 1 juvenile specimen that may be included in this group, till more material from that locality is available for comparison. It closely resembles the Mergui specimens in its general look.

All those creatures agree with Blyth's description of this species in colour of the fur. In size too, one large shrew from Mergui, No. 4815, male, measures: head and body 150; tail 68; hindfoot 20; ear 15. Another from Pegu, No. 585, female, measures: head and body 133; tail 70; hindfoot 18; ear 12·5.

There has been great confusion in the use of the specific name of *fuliginosus* which Blyth plainly applied to a *Suncus*. Anderson, in his Catalogue of Ind. Mus. 1881, describes *Crocidura fuliginosa*, a creature of 2·9 inches long and gives in the synonymy the reference to Blyth's paper which established *Sorex fuliginosus* quoted above. Blanford repeats this in 1888 in his *Mammalia*, p. 242, and Cabrera also in 1925 does the same thing. Thus the mistake was perpetuated, but is now exposed. The type specimens are No. 253, A. B. of Blyth's Catalogue (Nos. 242 a, b of Cat. Mamm. Ind. Mus.)

16. *Suncus subfulvus*, Anderson, 1877. *J.A.S.B.*, vol. xlvi, p. 278.

A series of 19 shrews from Kathiawar and 5 from Sind agree so closely with the description of *Suncus subfulvus* given by Anderson in *J.A.S.B.*, vol. xlvi, p. 278 and differ so much in size from *Suncus cæruleus sindensis*, though they are fully adult, it seems best to call them by this specific name. Mr. Wroughton in Report No. 24 of the Mammal Survey on the specimens from Sind notes 'three of the specimens from Sukkur are young and the fourth is a nursing ♀. The young agree quite closely with Anderson's description."

Anderson thus describes this species 'Snout rather short and 'broad; ears moderately developed, rather flattened above; feet 'moderately large and tolerably well-clad; with pale-coloured hairs 'which hang over the strong yellow claws; general colour of the 'upper surface pale fawn, hairs ashy at base, the underparts silvery 'grey.'

Dimensions : Specimen No. 2552, male from Dhrangadhra, Kathiawar, may be taken as typical. Head and body 70; tail 46; hindfoot 10·5; ear 8. Specimen No. 706 from Sukkur, Sind, the nursing ♀ of which Wroughton speaks, measured Head and body 74; tail 48; hindfoot 11; ear 10. The average of 10 specimens gives head and body 69; tail 44; hindfoot 11; ear 9. *Habitat.* Kathiawar, Sind. Type specimens described by Anderson are Nos. 238 a, b of Cat. Mamm. Ind. Mus.

17. *Suncus stoliczkanus*, Anderson, 1877. *J.A.S.B.*, vol. xlvi, p. 270.

The Survey obtained 19 specimens of this species a set of 14 from Gwalior, 2 from Salsette, 2 from Nimar and 1 from Hoshangabad in the Central Provinces. These all agree with the description of the type specimen given by Anderson in *J.A.S.B.*, vol. xlvi, p. 270. 'Snout rather short and broad, not densely clad; feet 'well developed but not large and rather thinly clad, claws 'moderately long and pale yellow. Tail not swollen at the base; 'snout, hands, feet and upper surface of the tail pale yellowish 'brown; fur soft, silky; dull brown above, dark grey on the underparts, some with silvery sheen.' The upper surface of the tail resembles the body colour, and the tail tapers to a very fine point ending in a pencil of hairs.

Dimensions: Anderson gives the measurements of his type specimen as: head and body 63; tail 48; hindfoot 12; ear 8. The average of 10 specimens from the Survey series gives: head and body 73; tail 48; hindfoot 11·8; ear 9. Specimen No. 529 from Guna, Gwalior, may be taken as typical—head and body 75; tail 48; hindfoot 11; ear 9. Anderson's type is No. 2336 of Cat. Mamm. Ind. Mus.

18. *Suncus nitidofulvus*, Anderson. 1877. *J.A.S.B.*, vol. xlvi, p. 272.

1856. *Sorex melanodon*, Blyth. *J.A.S.B.*, vol. xxiv, p. 33.

This set of 27 specimens collected at Luia, Chaibassa, are so different from the other small shrews in N. E. India and agree so closely with the description of this species given by Anderson in *J.A.S.B.*, vol. xlvi, p. 272 it has been decided to call them *Suncus nitidofulvus.* Anderson describes this shrew as having 'limbs 'rather feeble, seminude in lower portion of legs, the upper surface of 'the feet being sparsely clad with short whitish hairs. Claws well 'developed, yellowish. General colour above shining brown, under 'surface greyish brown with sometimes a silvery sheen; fur soft, 'short, silky; tail is tapering, rounded.' He gives the measurements of a fully adult female: head and body 45; tail 27; hindfoot 8; ear 4·5.

The average dimensions of 10 specimens are: head and body 48·6; tail 37; hindfoot 9; ear 6·3.

Anderson gives as the habitat of this species Lower Bengal. It is distinguished from *S. micronyx* by its larger, stronger claws and colour of the body, being much lighter brown on the upper surface and much browner on the under surface. The whole series agrees in these characters. Anderson's types are Nos. 234 f, g of Cat. Mamm. Ind. Mus.

19. *Suncus micronyx*, Blyth. *J.A.S.B.*, vol. xxiv, p. 33.

A specimen No. 4168 was taken by the Survey at Ramnagar, 30 miles W. of Naini Tal on the way to Masuri. It is an adult male agreeing in all particulars with the description of *Suncus micronyx* given by Blyth in *J.A.S.B.*, vol. xxiv, p. 33. The fur is buffy brown on the back and head, grey below with a silvery sheen. The feet and tail with very close fur, the tail brownish above, paler below. The claws are small and fine, the feet slender and toes long. The ears are rather prominent. The skull is very small, 12 mm. in greatest length. Blyth gives as measurements of the type specimen No. 258 B of his Catalogue (No. 2406 of Cat. Mamm. Ind. Mus.) head and body 41; tail 28; hindfoot 10; skull 12·5.

This specimen from Kumaon measures: head and body 41; tail 32; hindfoot 8; ear 6; skull 12. Another specimen resembling this one was taken at Dhamtal, Kangra. This, No. 3066, has the same configuration and colouration as No. 4168 from Kumaon, but it measures: head and body 52; tail 31; hindfoot 8; ear 6. There is no skull available for examination.

20. *Suncus perrotteti*. Duvernoy. Mag. Zool. 1842, p. 29.

This is the tiny shrew of the Nilgiris and Southern India. Blanford describes it as having 'large ears; feet thinly clad above; 'very thin tail tapering towards the end; fur short, reddish brown 'to dark brown, paler below' (but not glistening as in *S. nudipes*). Duvernoy notes in *Mag. Zool.* 1842, p. 29 that the lower incisor is straight, its extremity scarcely recurved and obtuse.

The Survey obtained 4 specimens in Bellary and 2 from Coorg, Specimen No. 1456 from Vijayanagar, Bellary, is recorded to have contained 4 young when caught. It measures head and body 49; tail 35; hindfoot 8; ear 6. The average measurements of the 5 adults are: head and body 48·2; tail 32·8; hindfoot 8; ear 6·1. Duvernoy gives measurements of his only specimen ♂ taken at 2,300 metres on Nilgiris as body 37; tail 34; H.F. 8.

21. *Suncus nudipes*, Blyth. *J.A.S.B.*, vol. xxiv, p. 24, 1855.

Blyth describes this species as 'remarkable for its naked feet and 'large ears; tail almost nude; fur uniform brown above, a little 'grizzled and glistening; the lower parts with a silvery shimmer; 'tail brown above, pale below, uniformly tapering.' He gives as the measurements of his type from Amherst, Tenasserim, head and body 43; tail 27; hindfoot 8·5. Of the 5 specimens taken by the Survey 3 adults came from the Jaintia Hills, Assam, one adult from

Tenasserim and one juvenile from Hsipaw, Shan States. The average measurements of the 4 adults give: head and body 48; tail 30·5; hindfoot 8·5; ear 6. One specimen, No. 892, male, from Shangpung, Jaintia Hills, measures: head and body 45; tail 30; hindfoot 8; ear 6.

The face in all these shrews is elongated in shape. The feet are very slender and delicate in make. Blyth's type specimens are No. 254 A—E of his Catalogue and Nos. 234 A—E of Cat. Mamm. Ind. Mus.)

22. *Suncus pygamæoides*, Anderson. 1877,

J.A.S.B., vol. xlvi, p. 279.

1845. *Sorex pygmæus*, Hodgson, *A.M.N.H.*, vol. xv, p. 269.
1867. *Sorex hodgsoni*, Jerdon. *Mammals of India*, p. 57.

This group represents the *Sorex pygmæus* of Hodgson which he described in *A.M.N.H.*, vol. xv, p. 269 as having 'colour 'sootybrown, paler below; naked parts of a dusky fleshy hue, snout 'to vent less than 2 inches; tail $1\frac{3}{16}$; head $\frac{11}{16}$; palma $\frac{1}{4}$; planta $\frac{3}{8}$.' Jerdon in 1867 called the group *Sorex hodgsoni*, the Nepal Pigmy Shrew. He describes it as 'uniform brown with a slight tinge of 'chestnut, scarcely paler below; feet and tail distinctly furred; 'claws whitish and conspicuous; tail brown above, pale beneath, 'tapering evenly throughout.' Both descriptions are verified in the collection of 25 specimens from Hasimara, Bhutan Duars and 4 from Darjiling District. The name Hodgson gave has been applied to a European species of *Sorex*, by Laxmann in 1769 in *Sibirische Briefe*, p. 72; the name Jerdon used was intended by Blyth to represent *Sorex perrotteti*, a species resembling the Himalayan shrews in colour but differing in details. Blyth himself said that the 'Darjiling female approximates to the description.' As these two names are invalid, the next oldest name given by Anderson in 1877, *Crocidura (P.) pygmæoides*, must stand. He describes this shrew in *J.A.S.B.*, vol. xlvi, p. 279 as having 'snout 'rather long and narrow, pointed, well clad; ears well developed; 'feet well developed, rather long and slender, toes moderately 'long, claws strong and curved. Lower portion of all limbs clad 'with short brown hair; feet rather sparsely clad with the same. 'Tail rather long, densely covered with short brown hair; fur short, 'soft, silky. General colour rich deep, rusty brown, underparts 'brownish with a marked silvery sheen.' Anderson gives as the measurements head and body 1·85 ins. (46·25 mm.); tail 1·4 ins. (35 mm.); hindfoot ·37 ins. (9·2 mm.); ear ·2 ins. (5 mm.).

In the series of Survey specimens No. 936 from Pashok, Darjiling, corresponds exactly to this description and may be taken as typical. It measures: head and body 46; tail 35; hindfoot 9; ear 5. It differs from *S. perrotteti* in its smaller ear, broader head, longer forearm, deeper colour, tail not white below. It differs from *S. nudipes* in its broader head, smaller ear, duller fur and longer tail. Its habitat is the Himalayan slopes.

23. *Suncus leucogenys*, Dobson. *A.M.N.H.*, 6, p. 428.

No specimen of this species has been taken by the Survey but in the National Collection are three shrews which bear out the description given by Dobson in *A.M.N.H.*, 6, p. 428 in 1888. He says that the 'ears are short and clothed with a few whitish hairs; the tail is thick and fusiform; feet are small and slender; the fur is short, above light cinnamon brown with a reddish tinge mixed with the grey, basal half of hairs bluish; the sides of the head between the angles of the mouth and ears, the chin and part of the chest are dirty white, remainder of the ventral surface greyish; tail upper surface like the back, under surface like the belly.' Dobson gives the measurements of an adult male as: head and body 75; tail 47; ear 8; hindfoot 12. The nearest to this is specimen No. 339 collected by Major Dunn at Drug, Rajputana, which gives: head and body 70; tail 45; hindfoot 11; ear 9. The skull of this specimen is broken, but the skull of the type specimen (which is in alcohol) is available and agrees with the fragments of No. 339.

24. *Suncus dayi*, Dobson. *A.M.N.H.*, 6, p. 428.

Of this species only one specimen was obtained by the Survey and that came from the Palni Hills. It is in alcohol. The type specimen is a skin in the National Collection and has thus been described by Blanford: 'upper teeth 18; size rather small; snout hairy; ears not large; feet thinly covered with hair above; tail long, thinly covered with short hairs. Dobson describes the specimen as having fur and integument dark brown throughout, the ventral surfaces slightly paler, the basal three-fourths of the fur on both surfaces being dark bluish grey. The teeth differ in the shape of the first upper incisor as well as in the large size of the first premolar, which is much larger than is usual in the genus. The lower incisors are serrated above.' Dobson gives the measurements: head and body 74; tail 60; hindfoot 15·5.

Only these two specimens of this group are known. The label of the skin in the National Collection bears 'Madras' but Blanford surmises that this specimen came from the Palni Hills. The skin, in colour and in its long hindfoot and thin long tail bears resemblance to *Suncus niger* which the Survey collected in the Hill areas of Madras Presidency. But the skulls of these two species are distinct, the main difference being the very large size of the first premolar in *Suncus dayi*. More specimens of this species from the Madras area would be most useful for comparison.

25. *Suncus rubicundus*, Anderson, *J.A.S.B.*, vol. xlvi, p. 277.

There is no specimen of this species available for examination. Only one specimen (from which the species was named by Dr. Anderson) was obtained on the slopes of Paresnath Hill, Bihar and Orissa. The Survey collected 6 specimens of *Suncus cæruleus cæruleus* at Nimiaghat, the village at the bottom of Paresnath Hill and whence the path to the top of the mountain starts. One specimen

No. 5133 was actually taken on Paresnath itself and is undoubtedly a true *Suncus cæruleus*. It agrees exactly with the description of *Suncus rubicundus* as given by Blanford. Since these specimens were taken in the same place and agree with the description of the species given by Anderson and Blanford, it is reasonable to conclude that the species was founded on a young shrew of *Suncus cæruleus cæruleus*. Specimen No. 5229 taken at Nimiaghat and recorded as a juvenile agrees in colour of fur, and its dimensions are: head and body 76; tail 38; hindfoot 16; ear 8. The dimensions of the type are: head and body 85; tail 57; hindfoot 16; ear 8·2.

A STUDY IN INSECT PROTECTION

(*ANOPLOCNEMIS PHASIANA*, FABR.)

BY

MAJOR R. W. G. HINGSTON, I.M.S.

(*With two plates*)

The scheme of Nature is so closely knit; all living things are so dependent on one another that many and varied schemes have been devised for maintaining existence in the contest for life. One animal has gone in for cryptic coloration, another for some type of offensive weapon, another for some artful method of escape; then others have taken to the ruse of mimicry, others to the development of nauseous juices, others to the emission of noxious fumes. And so on, ruse after ruse. In nothing has Nature shown more ingenuity than in the creation of protective schemes.

But the point which I wish to make here is that we often find in the same species not merely one of these protective devices, but rather a combination of several devices on the interaction of which its existence depends. These devices may exist at the same time, or may follow one another as the creature develops. But in either case, whether simultaneous or successive, each device has its function to fulfil at some particular place or time. Let us, therefore, consider one species of insect, a conspicuous example with a simple history, and observe its manner of dealing with this problem at successive stages of growth. We will not delay on anatomical development. It has not the interest to the field observer that have instincts and living acts.

The species in question is *Anoplocnemis phasiana*, a large bug, repulsive in appearance, which may sometimes be seen on young foliage after the rains have set in. Different kinds of vegetation attract it; but its favourite plants in Central India are *Cassia occidentalis* and *Ægle marmelos*. It is a stout insect, black throughout, except for some yellow near the tips of its antennæ, and on its back an orange patch which is ordinarily hidden by the closed wings. It possesses a peculiar geometrical appearance, as though built on some cubist plan. (See Plate 1, Fig. 5.) Its thorax is a sloping equilateral triangle; its abdomen is isosceles in shape. Its wings, owing to the way in which they overlap, make a pattern of geometrical figures on its back. But look at its hind legs. They are very extraordinary. Those of the female show nothing in particular, but in the male they are distended into clubs and furnished with a strong tooth. On the whole we have an insect of grotesque appearance, repulsive by reason of its black colour and the extravagant conformation of its parts.

Let us pass to its development and growth. In July I see the sexes in union. It is a prolonged affair, without much enthusiasm, and takes place on the terminal shoots of a plant. Eggs are layed and spread along a stem. They are elongated cushions, convex above, but hollowed beneath so as to fit around the stem. Their number varies. In one clutch I count eight; in another nineteen. Their position, however, is always the same, a string of cushions touching one another, each about one-tenth of an inch long. (See Plate 1, Fig. 1.)

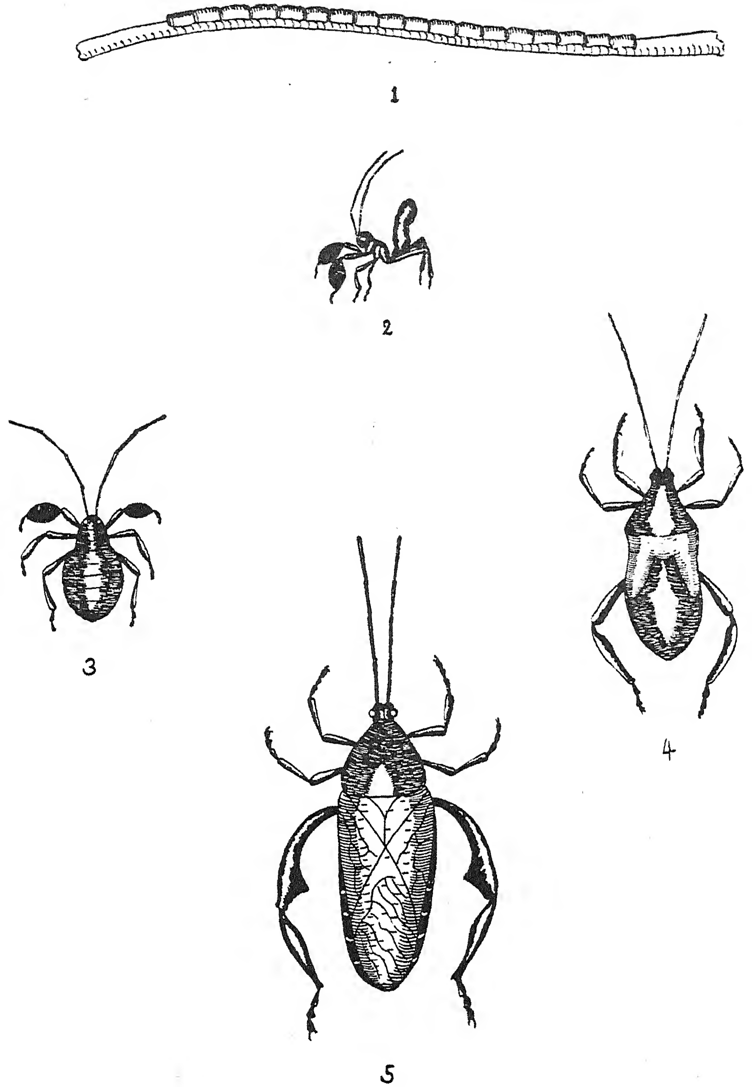
The casing of the egg is dark brown, delicately mottled, particularly at the sides, with a dash of silver grey. In this we have the first of our devices for protection. The eggs are mottled to harmonize with the stem; furthermore their arrangement in linear series helps to bring about the same effect. Though freely exposed, they blend well with their support; at most they look like a simple swelling along the line of the brown stem. Hence we have the ruse of protective coloration at the earliest stage of the insect's life.

Let us continue. Within the hard capsule of the egg a minute creature assumes shape. Its development occupies ten days. Then a breach occurs in the shell, a circular aperture at one extremity, so perfect that it might have been made with a punch. Through this gate of exit the little inmate emerges. First one egg opens, then another; until the whole family is born.

Anoplocnemis at birth is a spider-like object, absolutely black except for a stripe transversely across the middle of its back. Its tiny body is flat and triangular; its legs are spread around it in a cluster; its antennæ are held erect in the air. As a rule it remains still, but, if alarmed, it runs about with antennæ swaying and abdomen raised. The creatures are social at this period of their life. The family tries to keep together, the members employing their long sensitive antennæ for the purpose of maintaining touch. Soon after birth it begins to feed. It has a long beak like a straight lance. This it pushes into the plant. Through it sap is drawn to the mouth and life's continuous gorge begins.

The next event is the casting of its skin, which takes place on the fourth or fifth day. The superficial integument is shed, and out comes the bug in a new dress. Though larger in size, it is little changed in appearance, being still the same jet black colour. Its legs have the same spider-like appearance. One thing, however, we do begin to notice. The tibiæ on the front pair of legs are flattening into a pair of blades. Also we observe that it is less socially inclined. The family shows signs of scattering. Individuals wander away on their own and collect in twos and threes on various tender shoots.

The second moult accentuates these changes. The insect is now distinctly bigger. Also it is one of the most illshaped little creatures that one could anywhere expect to see (See Plate I, Fig. 2). In length about quarter of an inch, it is absolutely black save for bands on the antennæ and a pale line across the middle of its waist. Its gait is awkward and attitude unnatural. Its long antennæ are held erect; its abdomen hoisted; its fore legs, dilated into flattened plates, are thrust out conspicuously in front. It gives out a slightly



DEVELOPMENT OF *Anoplocnemis phasiana*.

1. Line of eggs affixed to stem.
2. Insect after second moult.
3. Insect after third moult.
4. Insect after fifth moult.
5. Mature insect.

Anoplocnemis in gun-firing attitude.

unpleasant odour, a foretaste of the foul effluvium which develops at a later date. All in the family have now scattered. Singly they crawl from shoot to shoot, their queer-shaped bodies apparently well fitted to the slow paces of their ill-proportioned legs. Like so many devilkins they stalk about, looking as if out of place in this creation, and more fitted to some prehistoric life.

Now what is the reason for this strange conformation? I regard it as the second of the devices used by this creature for its defence. The raising of the abdomen and the dilatation of the front legs are the points which concern us here. Why do these exist? The hoisting upward of the abdomen is certainly protective. Many poison-squirting insects habitually do it, for instance different species of ants. *Cremastogaster* ants are specially instructive, for when other ants are near them when they raise their abdomens, the other ants immediately rush off. What raising of the abdomen implies to an enemy is the danger of a poison squirt. Now, the bug, at this stage, possesses no poison. What then does it do? It mimics the poison-squirting movement. It gives an enemy the false impression of having a poison jet.

A brief digression may be instructive. Are there any other creatures in my district which employ the same deceitful plan? I will mention a few. Rove-Beetles abound at the margin of the river. They are elongated insects with stunted wings. Alarm one of them, and see what happens. Up goes its abdomen into the air after the manner of poisonous ants. Rove-Beetles, of course are perfectly innocent. The hoisting act is pure deceit. Here is another instance. A Tabanid fly, *Gastroxides ater*, used to visit the tree-trunks in my garden. It was about as large as a bluebottle and conspicuously marked with an orange coloured band. Alarm it, and what did it do? Not fly away like an ordinary bluebottle. It raised its abdomen over its back, then elevated and depressed the erected point like a wasp when protruding and drawing in its sting. Again another deceitful business, for the fly has not a trace of a sting. Moreover, it seemed to know the value of its ruse. It was unusually careless of intrusion. I could even stroke its body while it tilted its abdomen into the air.

Now for the flattening of the front legs. Why is this? It is another of these simulating devices. Raptorial insects, which clutch hold of their victims, often have their front legs flattened into blades that are armed with sharp teeth. *Anoplocnemis* has no armoury of teeth, but the flattening into blades is distinctly marked. Moreover, it thrusts them out in front, the attitude which raptorial insects assume. Hence we have another of these simulating devices. The insect is really perfectly harmless, but it looks the very essence of evil and danger. By hoisting the abdomen it pretends to be poisonous; by having flattened front legs it pretends to be raptorial. It is nothing but a bundle of deceit.

But in addition to these simulating ruses the creature has still another method of securing protection from attack. I often find it on the foliage of the Bael tree with its spear stuck in the youngest shoots. It sucks up the sap. The leaves wither, then droop in a shrivelled cluster and end by getting absolutely black. The bug,

however, remains beneath the cluster and keeps on draining at the sap. Now, the leaves in this withered state, are exactly the same black colour as the bug; moreover, they droop in an unsymmetrical cluster like the shapeless conformation of its body and limbs. Also some of the leaves are tiny, and the smallest of them are exactly the same shape as the insect's dilated legs. The cluster is therefore a vegetable shield beneath which the insect is hidden from view. Nor must it be thought that the occurrence is just casual. On the contrary, it is the habit of the creature to get under this canopy of blackened leaves. Here then we have still another device. The bug, through its own sucking operations, constructs for itself a vegetable canopy, which canopy helps to protect it by blending with its colour and shape.

Let us proceed. Its development continues. A third moult occurs, the transformation taking place underneath the black canopy where the insect is comparatively safe. The creature is now larger, five-sixteenths of an inch long, and still the same flattened shape. (See Plate 1, Fig. 3). The dilatations on the front legs are somewhat smaller; on the back of its abdomen are two small pores that were scarcely visible at the earlier stage. The ruse of erecting the abdomen has gone. The insect has become much more sluggish. It remains for a long time stuck to a shoot, sucking at it till the leaves are completely dry. In fact it is changing into a sucking-machine, with no business in life but to drain out sap, and no other event in its monotonous existence beyond the periodical shedding of its skin.

I have said that two small pores appear on its back. What are these? Still another of this insect's defensive methods. They are apertures of exit for nauseous juice.

A fourth moult shows further changes. The dilated front legs have practically gone. The body is growing more in length. Stumps, which represent future wings, are developing along its back. It has got too large to hide beneath a canopy. Some other kind of defence is needed. So conspicuous a creature must have some kind of ruse to protect in on the open leaves. The new ruse is the pair of pores which shoot out a disgusting juice. Also it has taken to another device, that of falling to the ground the instant anything touches its stem.

A fifth moult brings out still larger wings. A double pair are quite distinct, upper ones, large and conspicuous; lower ones tucked in underneath. The dilated front legs have completely disappeared. All the devilkin appearance is lost. (See Plate 1, Fig. 4.)

The sixth moult gives us the mature insect. The event is one of considerable change. Hitherto we have had a gradual transition; this is like witnessing a new birth. The great change is mainly due to the wings. At one stroke they appear to have been suddenly created out of mere triangular stumps. They now cover the abdomen back to its extreme tip.

The full-grown bug is an ugly creature, massive, angulated, exactly one inch in length. (See Plate 1, Fig. 5.) It sits at the extreme tips of the vegetation, clinging to one spot, beak in stem, continuing the persistent gorge. Probably its repulsive appearance protects it, but it also has a powerful weapon in the discharge that

issues from its pores. We have seen these pores during previous stages. They were placed on the dorsal surface of the abdomen, and from them fluid could be shot forth. But now the insect's wings have developed and cover the whole dorsal surface of the abdomen. Hence the pores will not work in that situation. A change in the squirting machinery must take place.

Let us investigate this change in mechanism and see how the new operation is performed. The bug is clinging passively to a leaf, hanging head downward from a terminal shoot like an angulated withered lump. Note particularly that the point of its abdomen is thrust erect into the air. (See Plate 2.) I bring a finger close to the insect. As I approach it, but before it is touched, out comes a sudden jet of liquid, and with it a penetrating smell. What has happened? A slit has opened at the tip of the abdomen, and from it a spurt of juice has been shot out to a distance of about a foot. Now see the reason for the insect's attitude. With head down and tail erect it is in the best position for firing its gun. Were the abdomen turned towards the ground then the insect would not have a clear field for its projectile and its fluid would be lost in the leaves. Thus it keeps its tail permanently elevated: its gun is always in readiness to fire.

In this we have quite a different arrangement from the squirting of fluid through pores in the back. The dorsal pores no longer function, for the area they occupied is now covered by the wings. In their place we have the more complicated apparatus, a protrusile organ at the tip of the abdomen, a telescope which, at the insect's will, can be made to open or close. When the bug is resting the telescope is sheathed, being drawn back into the abdomen and hidden under the wings. When danger threatens it is pushed out. A slit opens on its upper surface; the muzzle of the gun comes into view. Through this muzzle issues the nauseating jet. Then the telescope is drawn back and disappears beneath the wings.

The ejected fluid is clear and watery. Though in taste not unpleasant, its smell is disgusting. Any object on which it falls retains the odour for several hours. On evaporating, it discolours the fingers with a brick red dye.

In this forcible spurt of disgusting fluid we have a most valuable weapon of defence. The same thing occurs in Carabid beetles. I recall a particular species of *Anthia*. I touched it, and out from the end of its abdomen came a sharp explosive jet. The discharge was most irritating. It pricked the skin as if with fine needles, and burned the lips and eyes.

This power to shoot out irritating liquid is often associated with conspicuous markings. These serve as danger signals, beacons to warn off a foe. The creature not only possesses a weapon, but also a signal to tell that it is armed. Take the above mentioned *Anthia* for example. On its black body are white spots, large and highly conspicuous markings to warn an enemy not to approach. *Anoplocnemis* also flys a signal. It tells the enemy to keep clear. The signal does not show when the insect is stationary. It is then ugly and striking enough; no doubt its natural repulsive appearance will be sufficient to tell what it is. But when it has to take to flight

then it might be mistaken for something attractive ; an insectivorous bird might easily snap it up. But its signal guards against this possibility. When its wings open we see an apparition. Hitherto it was black all over, but now there appears between its wings a flash of fiery red. The colour is on the upper surface of its abdomen; it did not appear there till the last moult. Thus here we have another defensive method, a red signal flashing danger, only shown when the insect is in flight. The flash tells that the creature is offensive. A weapon lies hidden in the red gleam ; enemies had better keep clear.

The last of the devices employed by this insect is its habit of dropping to ground. The act is most marked in the later moults; and its value, of course, lies in the fact that the insect gets lost in the underlying scrub. Many tree-haunting insects adopt this ruse. I come across numerous examples in the neighbourhood. Weevils and Buprestids, a metallic *Cantharis*, a steel blue *Haltica*, a bright orange *Oides*, all adopt this plan of escape. I see Longicorn beetles and *Aulis* ladybirds dropping the instant they are touched. So do dung-beetles when they get into foliage and millipedes when they climb up grass. Tree-haunting spiders, byre-building ants, many different kinds of caterpillars all adopt the same simple device. It is a widespread habit of inestimable value, for the moment the insect falls to ground it gets lost in the forest of grass.

This concludes my remarks on *Anoplocnemis*. We have followed it through its whole development. How does it protect itself? Not by one stereotyped method, but rather by a crowd of different methods, each one specially adapted to a particular period of life. First we have camouflage or harmonization. The eggs blend with the supporting stem. Then comes deceit or simulation. The insect lifts its abdomen to suggest a sting, and grows a pair of flattened front legs that give the impression of cutting blades. At the same time another device develops, the drapery it manufactures of blackened leaves that blend both with its colour and shape. With growth these ruses cease to be effective. Then the creature takes to dropping to ground. Also it develops two pores on its back from which it squirts an offensive juice. But its wings grow and cover these pores. Consequently it develops another machinery, a telescope at the end of its abdomen from which issues a nauseous jet. One last touch to complete the system. This is the warning flash of colour, the red signal of danger which illuminates its flight.

Build up defences to guard against your enemies. This is one of Nature's strictest orders. Every kind of cunning, every kind of skill seems to have been thrown into this necessary work. We cannot discuss the whole assortment of devices. *Anoplocnemis* has collected more than its share of them. Camouflage, simulation, dropping to ground, canopy manufacture, shooting out fluid, flying warning signals, no small collection for a single species in its ceaseless struggle to live.

A LIST OF FISHES TAKEN IN TRAVANCORE FROM 1901–1915

BY

R. Shunker Narayan Pillay, c.m.z.s.

(*Late Curator, Trevandrum Museum*)

Introdution

The present paper on the Fishes of Travancore, with no claims to originality in respect of any of the facts, is the outcome of my studies, when as Curator to the Trevandrum Museum I was occupied in making a collection of local fishes, and in arranging the material for the Index to Fish in 1902, based on the notes taken by the late Capt. Harold S. Ferguson, f.l.s., f.z.s., etc., Director, from the S. Kensington Natural History Museum. The latter, it is much to be regretted, is far from complete and has been in abeyance since 1915. This paper, as I have already mentioned in my note on the Travancore Cetaceans published in the *Journal of the Bombay Natural History Society* (No. 3, vol. xxxi, November, 1926), is intended as a continuation to the series of articles on the Vertebrate and Invertebrate Zoology of Travancore, which have appeared in the same Journal from time to time. When Capt. Ferguson retired in 1904, there was already the nucleus of a modest collection, confined to Trevandrum.

During the following six years, thanks to the liberality of Lt.-Col. F. W. Dawson, i.a., the then Director, who placed funds at my disposal for the purchase of specimens for the Museum, I availed myself of the opportunity to devote special attention to this group of the animal kingdom, both at Trevandrum and during collecting tours, with the result that in 1915, the collection comprised of 369 species referable to 74 families, the major portion being obtained from Trevandrum and Cape Comorin.

I may venture to think that if at this rate the other districts of Travancore, with its sea-board, its fresh and brackish-water lagoons, the chain of back-water, stretching along the coast and communicating with the sea in different places, and the tanks and rivers, were systematically investigated, and the results published as Administration Reports, as had been the case from 1900 to 1909 (during the greater part of which the Museum and Public Gardens were under a Committee of Management, invariably presided over by the British Residents), considerable additions to the local collections would

have been made, and many interesting and rare finds brought to light.

On this point, a reference to the Administration Reports of the departments referred to above, will bear ample testimony to the fact that there are 5 Mammals, 6 Reptiles, 11 Batrachians and 20 Arthropods from Travancore, described as new to science, beside the new species of Oligochœtes, Porifera and Polyzoa, etc., subsequently embodied in the volumes of the '*Fauna of British India*' series.

Of the 20 fishes recently added to the local collection, one ray found for the first time in Travancore, was determined by the late Dr. Nelson Annandale, D.SC., F.R.S., Director, Zoological Survey of India, Calcutta, as the adult of *Raia powellii*, sp. n., on the evidence of a solitary immature ray, taken in the Gulf of Martaban.

It may be safely asserted that Dr. Day's '*Fauna of British India, Fishes*,' 2 vols., 1880, which is an abridgment of his original monumental work, '*The Fishes of India*,' 1876–1878, and which hitherto has been the only work of reference, may be regarded as more or less out of date in the light of the recent advances made by our knowledge of Indian Ichthyology during the last two decades in various parts of India, notably in the Indian Museum, Calcutta. Here among the innumerable additions to the Genera and Species, the acquisition of *Gobius alcockii*, (about ½ an inch long) one of the smallest of vertebrates, found in association with the common fresh-water sponge (*Spongilla carteri*), forms an important and interesting discovery.

Furthermore, the recent researches of the rising generation of naturalists, both in India and abroad, have effected such remarkable changes in the classification that numerous Genera have come to be recognized as Families.

The vernacular names of fishes, dealt with in these notes, form subjects for controversy, in that, they are neither reliable nor significant, and vary according to the age and color of fishes, as well as to their sex and locality, so that some of the names are indiscriminately applied to fishes of different families, which is more or less a source of confusion. Since the information herein contained, is entirely popular, and has already appeared in a large number of zoological publications, I have not thought it desirable to quote references to authorities.

In conclusion the kind reception, accorded to my note on Travancore Cetaceans by the Bombay Natural History Society, has prompted me to prepare the present one, more with a view to presenting to the public, for the first time, almost all the fishes recorded in Travancore, than under any misapprehension as to the completeness of the collection : but however imperfect this attempt may be, I shall feel amply rewarded, if this will serve as a starting-point for further investigation and its defects treated with indulgence by the scientific public.

CLASS. FISHES

The Animal Kingdom is divided into several groups or sub-kingdoms, in each of which the members have some affinity in

common. To one of these groups belongs the class of Fishes, which constitutes one of the main divisions into which the Craniate Vertebrates are classified.

The shape of the body is more or less like that of a spindle, tapering at each end, and varies according to the different modes and habits of life. For example, it is cylindrical, elongate and serpentiform in the Eels (*Murænidæ*); compressed and leaf-like, with the eyes on one side of the head, in the Flat-fishes (*Pleuronectidæ*); depressed and discoidal, with a whip-like tail, furnished with a serrated spine, in the Rays (*Trygonidæ*); depressed and elongate in the Skates (*Rhinobatidæ*); compressed and band-like in the Ribbon-fishes (*Trichypteridæ*); compressed and strap-like, with the tail ending in a filament, in the Hair-tails and Scabbard fishes, (*Trichiuridæ*); more or less round and trunk-like, in the Box-fishes (*Ostraciontidæ*); the head and body depressed and enlarged in the Frog-fishes (*Pediculati*); the head abnormally developed into two hammer-shaped lobes in the Hammer-head Sharks (*Sphyrnidæ*); the head and body resembling the knight of the chess-board in the Sea-horse (*Hippocampus*); and like the stalk or blade of grass, in the Pipe-fishes (*Syngnathidæ*).

The body is covered with scales, which are of four different types, namely :—

1. *Cycloid*, which are thin horny plates, with the edges smooth.
2. *Ctenoid*, which are thick horny plates, with the posterior margin serrated or comb-shaped.
3. *Ganoid*, which are hard bony plates, covered with enamel.
4. *Placoid*, which are detached bony plates or tubercles, resembling the teeth of sharks and rays.

The limbs of fishes, which correspond with the anterior and posterior extremities of the higher vertebrates, are modified into fins and are called the *pectoral* and *ventral* fins respectively. The former, are situated on either side, behind the gill-openings, and the latter behind the pectorals. These are *paired*, and like the *unpaired ones* (*dorsal*, *anal* and *caudal*), which are also present, are furnished with supporting fin-rays. The *pectoral* fins are constantly placed high up or down below the sides of the body, on the dorsal aspect, of the gill openings. They are absent in some Eels, though abnormally developed in the Flying-fishes and the Paradise or Mango-fishes of India, the lower portion of the pectoral fins in the latter case being modified into long slender filaments. —The *ventral* fins are smaller and far more variable in position than the *pectorals*. They are absent in the Eels, and when present in the *Physostomi*, are situated far back on the belly, behind the *pectorals* (*abdominal*). In the *Percidæ*, they are situated far forward, under or just behind the pectorals (*thoracic*) and in the Cod-fish, on the throat, in front of the pectorals (*jugular*). The caudal fin is often forked. Locomotion is effected by the action of the tail and the caudal fin, the function of the other fins being only of secondary importance.

The first pair of gill arches is modified into jaws and the embryo develops without any amnion or allantois, which constitute one

of the most important appendages for the safe reception and protection of the embryo.

Breathing in the majority is effected solely by gills, though some fresh-water forms possess a lung in addition. The heart is situated behind the gills, and consists of only two chambers. Like the Reptiles and Amphibians, fishes are *cold-blooded*, that is to say, they have not the power of generating heat of themselves and withstanding the rise and fall of the temperature of their environment, owing to the absence of a controlling nervous mechanism.

The eyes are destitute of true eye-lids, and there are no external traces of an ear-opening. The nasal pits have no communication with the mouth cavity, and there is usually a lateral line of sense organs on both sides of the body, extending from the back of the head to the tail. The scales that cover this, are found on a closer examination, to be channelled and perforated, showing the presence of nerve-endings, like the loreal pit of Pit-vipers.

Subclass I. CHONDROPTERYGII

Sharks, Rays and Chimæras

Order 1. PLAGIOSTOMI

Suborder 1. *Selachoidei*

Family I. SCYLLIIDÆ

The Dog-fishes are sharks of predacious habits, having a wide range of distribution. They are oviparous, i.e. the young are hatched out, after the extrusion of the eggs.

1. *Stegostoma tigrinum*. Tiger-shark. Vern.: 'Udoomboo-sorah'.
   Trevandrum, December.
   A fairly common edible fish, said to reach a length of 18 ft.; it is a source of endless trouble to fishermen, destroying their nets and their contents.
2. *Chiloscyllium griseum*. Dog-fish. Vern.: 'Korangu-sorah'.
   Trevandrum, November.
   A shallow-water shark, not recorded in Dr. Day's *Fauna of British India*.

Family II. CARCHARIIDÆ

Viviparous sharks without dorsal spines.

3. *Carcharias laticaudatus*. Shark. Vern.: 'Aul-pidiyan'.
   Trevandrum, November.
4. *Carcharias walbeemi*. Shark. Vern.: 'Perum Sorah'.
   Trevandrum, December.
5. *Carcharias melanopterus*. Shark. Vern.: 'Ramen Sorah'.
   Cape Comorin, December.
6. *Galeocerdo rayneri*. Zebra-shark. Vern.: 'Valluvan Sorah'.
   Trevandrum, July.
   It is said to grow to upwards of 12 ft. in length.

The fins of sharks are exported from Travancore to foreign countries, where isinglass is prepared from them. The rough skin (*Shagreen*) is used by artificers for polishing wood, and the oil extracted from the liver is used in medicine as an efficient substitute for cod-liver oil.

Family III. Sphyrnidæ

These fierce and voracious creatures are called the Hammer-head Sharks, from the abnormal lateral expansion of the head into two depressed hammer-shaped lobes, at the distal extremities of which the eyes are situated and the nostrils along the margin. They are said to grow to 15 ft. in length, and to occur in almost all warm seas. The flesh is much esteemed.

7. *Zygæna malleus*. Hammer-head Shark. Vern.: 'Chatti-thalayan'.
   Trevandrum, March.
8. *Zygæna tudes*. Hammer-head Shark. Vern.: 'Madayan Sorah'.
   Trevandrum, March.

Family IV. Rhinodontidæ

The Basking-Shark, otherwise known as Whale-Shark or Basker, is so called from its fondness for lying at the surface of the sea in warm weather, as if basking in the sun's rays with the upper part of the body exposed.

9. *Rhinodon typicus*. Basking-Shark. Vern.: 'Pulli-udoombu'.
   Trevandrum.
   A carcase of this shark was stranded at Trevandrum in 1900, measuring 29 ft. with the greatest circumference of the body 11 ft. 3 in. and the largest tail-fin 6 ft. 3 in.
   A specimen 13 ft. 7 in., reproduced as a painted plaster cast, is exhibited in the Fish-Gallery, Trevandrum Museum.
   This shark is hunted for the large quantity of oil it contains; it is said to reach a lenghth of 50 ft. to 70 ft. It is not aggressive unless molested.

Suborder 2. *Batoidei*

Family I. Pristidæ

The head of the Saw-fish is prolonged into a flat tapering snout, armed with quadrangular saw-like teeth along both edges, each tooth being firmly fixed in a socket. Its real teeth are minute and obtuse. The Saw-fish frequent estuaries of rivers and lagoons and are dreaded by fishermen and bathers on account of their saw-like weapon with which, they can inflict deadly wounds beside destroying the nets. They are known to reach a length of 20 ft. and to occur in the tropical and temperate seas.

10. *Pristis cuspidatus.* Saw-fish. Vern.: 'Vaul-sorah'.
Trevandrum, August.
During the winter of 1905, while engaged in making a collection of migratory birds, for the Trevandrum Museum, along the coast of the Vembanad Lagoon, N. Travancore, I observed from a boat a Saw-fish about 5 ft. long, lying in ambush at the bottom, and rendered almost invisible by the color of the mud, which resembled its own. The flesh is excellent.

11. *Pristis perrottetti.* Saw-fish. Vern.: 'Komben-sorah'.
Trevandrum, June.
There is a record of this fish obtained by the Indian Museum, Calcutta, measuring 21 ft. long.

Family II. RHINOBATIDÆ

The Skates are intermediate forms between the sharks and rays, the body forming a depressed disc.

12. *Rhynchobatus djeddensis.* Mud-skate. Vern.: 'Poonthi-sorah'.
Trevandrum, February.
The first specimen received by the Museum was a donation from Dr. A. Willey, F.R.S., Director, Colombo Museum, obtained during his Zoological Mission into Travancore in 1906.

13. *Rhynchobatus ancylostomus.* Mud-skate. Vern.: 'Kal-poonthi'.
Trevandrum, March.

14. *Rhinobatus granulatus.* Mud-skate. Vern.: 'Kal-poonthi'.
Trevandrum, March.
The skates are viviparous and their flesh is not savoury.

Family III. RAIIDÆ

The rays are destitute of electric organs and are armed with a barbed caudal spine. In defending themselves, they are said to bend their bodies in a bow and let themselves spring back with great force, causing serious wounds on the body of the victim with the spikes.

These are bottom fishes, and the genus with one species was recorded in Travancore for the first time in 1912.

15. *Raiia powellii sp. n.* Powell's Ray. Vern.: 'Thirandi'.
Trevandrum.
Dr. Nelson Annandale, to whom this ray was forwarded for specific identification, determined it as *R. powellii sp. n.* on the evidence of an immature ray obtained from the Gulf of Martaban.

Family IV. TORPEDINIIDÆ

The family comprises the Electric Rays, which are voracious edible fishes. The electrical organs are composed of vertically placed hexagonal prisms, situated between the head and the pectoral fins and are controlled by several nerve trunks.

16. *Narcine timlei*. Electric Ray. Vern.: 'Ullooku'.
    Cape Comorin, December.
    A specimen fresh from the net obtained at Cape Comorin, on being handled, produced a peculiarly numbing sensation when in a dying condition; it is a widely distributed species and is good eating.
17. *Astrape dipterygia*. Electric Ray. Vern.: Thanni-thirukay'.
    Cape Comorin, June.

Family V. Trygonidæ

These are the Sting-rays, having a flat disk-shaped body with the pectoral fins confluent with the snout. The tail is long and slender and whip-like, and armed near the base with a sharp serrated spine. The sting-rays are in the habit of enveloping prey within the folds of the tail, and forcing it on to the deadly spine, which is poisoned by the slime with which it is bathed. The teeth are flat and pavement-like.

18. *Trygon sephen*. Sting-ray. Vern.: 'Adavaulen-thirukay'.
    Trevandrum, June.
    A specimen of this ray stranded at Trevandrum in 1906 measured 5 ft. across the disk.
19. *Trygon walga*. Sting-ray. Vern.: 'Thirachi'.
    Trevandrum, June.
20. *Trygon pastinacea*. Common Sting-ray. Vern.: 'Thirukay'.
    Cape Comorin, November.
    Recorded in Travancore since the publication of the *Fauna of British India*, *Fishes*, by Dr. Day. This fish occurs off the coast of Norway and the British Isles, through the Atlantic and Indian Oceans to Japan.
21. *Pteroplatea micrura*. Short-tailed Sting-ray. Vern.: 'Meen-thirukay'.
    Trevandrum, June.
    Not uncommon at Cape Comorin.
    Dr. Jerdon has recorded a specimen, 3 ft. long by 6 ft. across the disk. The sting-rays are oviparous.

Family VI. Myliobatidæ

The Mill-stone rays, otherwise known as Devil-rays or Eagle-rays, are named after the peculiar structure of their jaws, which are paved with hexagonal teeth, adapted for crushing the hard shells of molluscs and crustaceans on which they feed. The tail is flexible, long and lash-like and armed with one or more serrated spines. By means of the bat-like expansion of the pectoral fins, the Eagle-rays envelope pearl-divers under water and drown them. They are edible and viviparous.

22. *Myliobatis neiuhoffi*. Devil-ray. Vern.: 'Sappa-thirukay'.
    Quilon, December.
23. *Aëtobatis narinari*. Eagle-ray. Vern.: 'Pulli Kaka-thirukay'.
    Trevandrum, August.
    An eagle-ray, taken at Trevandrum in 1906, was 6 ft. 4 in. from tip of snout to root of tail, 4 ft. 9 in. across

the disk; but the tail, which appeared to have been bitten off and healed, was 14 in. The tail of an immature fish, subsequently obtained, was 3 ft. long and the expanse of the disk 1 ft. 6 in.

24. *Rhinoptera javanica*. Bishop-ray. Vern.: 'Kaka-thirukay'.
Quilon, March.

25. *Dicerobatis ereegoodoo.* Mill-stone Ray. Vern.: 'Komben-thirukay'.
Trevandrum, March.
Full grown rays, are said to measure 18 ft. across the disk.

Order II. Holocephala

The family *Chimæridæ*, consists of only one living species, not represented in the Indian Ocean, though there are traces of their having, at one time, existed in the Bay of Bengal. The order forms a connecting link with the Ganoids.

Subclass II. DIPNOI

The *Lepidosirens* are known as double-breathers and possess a single lung and gills throughout life. Owing to certain structural peculiarities, many Zoologists are inclined to assign them to a separate class, intermediate between the Amphibians and Fishes. They are not represented in India.

Subclass III. TELEOSTOMI

This subclass comprises the true fishes, and is contrasted with the *Selachians* (Sharks), and includes both Teleosteans and Ganoids.

Order I. Ganoidea

The *Ganoids*, which are known as plated fishes, are covered with hard bony plates, having a smooth surface, coated with enamel. They are not known to occur in India, though some are found in Central Asia and China. Comparative anatomy shows that they are descended from the *Selachians* (Sharks) and the bony fishes (*Teleosteans*) from the Ganoids. The living forms include the Sturgeons and the Pike.

Order II. Teleostei

Suborder I. *Malacopterygii*

Family I. Elopidæ

The species are very few, though widely distributed in tropical and subtropical seas, sometimes entering fresh-water.

26. *Elops saurus*. Ten-pounder or Big-eyed Herring.
Trevandrum, November.
A handsome elongate silvery fish, occurring in the West Indian region, at the Cape of Good Hope, and off the shores of East Africa and in Oriental seas.

27. *Megalops cyprinoides.* Ox-eye. Vern.: 'Nanchil'.
Trevandrum, January.
Distinguished by the large scales, and the curiously elongated last ray of the dorsal fin. The Ox-eye often leaps out of the water, after the manner of Grey Mullet. The scales are over 2 inches in diameter, and are valued for fancy work. The young are ribbon-shaped.

Family II. CHIROCENTRIDÆ

Edible fishes with the body elongate and compressed, covered with deciduous scales. A single genus peculiar to the Indian Ocean and seas of Japan and China.

28. *Chirocentrus dorab.* Vern.: 'Thuppoo-vahlay'.
Trevandrum, October
The flesh is palatable.

Family III. CLUPEIDÆ

The Herrings and Sardines are migratory fishes, swimming in shoals generally near shores and estuaries. They are either dried in the sun or salted or smoked. Large quantities of oil are extracted from them, both in Travancore and on the Malabar Coast, from October to January.

29. *Clupea atricauda.* Herring. Vern.: 'Keeri-charlay'.
Trevandrum, October.
30. *Clupea longiceps.* Oil Sardine. Vern.: 'Pay-charlay'.
Trevandrum, December.
31. *Clupea fimbriata.* Oil Sardine. Vern.: 'Matthi-charlay'.
Trevandrum, January.
32. *Clupea sindensis.* Herring. Vern . 'Vatta-kanni'.
Trevandrum, August.
Also occurs in the Seychelles.
33. *Clupea kanagurta.* Herring. Vern.: 'Ayalay'.
Trevandrum, June.
34. *Clupea toli.* Herring. Vern.: 'Oolum'.
Trevandrum, June.
35. *Pellona elongata.* Herring. Vern.: 'Matthi'.
Trevandrum, June.
36. *Pellona brachysoma.* Herring. Vern.: 'Matthi'.
Trevandrum, September.
37. *Opisthopterus tartoor.*
Cape Comorin, November.
38. *Chatoessus chacunda.* Herring or Shad.
Trevandrum, June.
An estuary fish found in the rivers of Central India and Central America; usually sold dry in markets.
39. *Chatoessus nasus.* Indian Herring. Vern.: 'Pananjaulay'.
Trevandrum, June.
40. *Engraulis hamiltoni.* Anchovy. Vern.: 'Charlay'.
Trevandrum, October.

41. *Engraulis malabaricus.* Anchovy. Vern.: 'Poor-relan'.
Trevandrum, October.
42, *Engraulis mystax.* Sardine.
Trevandrum, October.
43. *Engraulis dussumieri.* Sardine.
Trevandrum, October.
44. *Engraulis parava.* Sardine. Vern.: 'Kutthavoo'.
Trevandrum, November.
45. *Engraulis commersonianus.* White-bait. Vern.: 'Netholi'.
Trevandrum, November.
46. *Engraulis indicus.* White-bait. Vern.: 'Co-netholi'.
Trevandrum, November.
47. *Dussumieria acuta.* Malabar Sardine. Vern.: 'Charlay'.
Trevandrum, December.
48. *Spratelloides malabaricus.*
Alleppy, December.
49. *Chanos salmoneus.* Milk-fish. Vern.: 'Poomeen'.
Trevandrum, October.
This is the White-Mullet of Europeans; the flesh is much esteemed and the adult is said to weigh 20 lbs. to 30 lbs.

Suborder 3. *Ostariophysi*

Family I. CYPRINIDÆ

Exclusively fresh-water fishes, noted for the small toothless mouth, which is more or less protractile and furnished with barbels; they are the least carnivorous of fishes and form objects of important culture in parts of the continent, and contribute largely to the food-supply of the people in Europe and Asia; but in America very few are of economic importance.

The Mahseer and Gold-fish are members of this family.

50. *Nemachilus botius.* Loach. Vern.: 'Auttu-meen'.
Tenmalai, November.
According to Dr. Day the Loach is not found on the Malabar Coast, nor south of the Krishna River.
51. *Nemachilus triangularis.* Loach. Vern.: 'Kal-nakki'.
Tenmalai, November.
Travancore Hills only. *F.B.I.*
52. *Homaloptera maculata.* Loach.
Tenmalai, November.
53. *Discognatha lamta.* Loach. Vern.: 'Koravai'.
Trevandrum, November.
54. *Discognatha jerdoni.* Loach. Vern.: 'Kal-nakki'.
Tenmalai, November.
55. *Amblypharyngodon mola.* Carp. Vern.: 'Oolari'.
Shencotta, November.
56. *Amblypharyngodon microlepis.* Carp.
Alleppy, December.
57. *Amblypharyngodon melittina.* Carp. Vern.: 'Airay'.
Sasthancotta, November.

58. *Labeo dussumieri.* Carp. Vern.: 'Toolee'.
Alleppy, December.
59. *Barbus pinnauratus.* Carp. Vern.: 'Panchala-kylie'.
Trevandrum, November.
60. *Barbus tor.* Carp.
Parappar River, November.
61. *Barbus curmuca.* Carp. Vern.: 'Kadi-meen'.
Trevandrum, October.
62. *Barbus lithopidos.* Carp.
Trevandrum, October.
63. *Barbus wynaadensis.* Carp.
Tenmalai, November.
64. *Barbus malabaricus.* Carp. Vern.: 'Auttu-kendai'.
Tenmalai, November.
65. *Barbus melanampyx.* Carp. Vern.: 'Kylie'.
Shoralacode, June.
66. *Barbus parrah.* Carp. Vern.: 'Kylie'.
Trevandrum, November.
67. *Barbus burmanicus.* Carp. Vern.: 'Sappauli-kendai'.
Cape Comorin, November.
68. *Barbus denisonii.* Carp. Vern.: 'Kendai'.
Mundakayam, December.
69. *Barbus melanostigma.* Carp. Vern.: 'Kendai'.
Cape Comorin, November.
70. *Barbus amphibius.* Carp. Vern.: 'Urulen-kendai'.
Trevandrum, August.
71. *Barbus arulius.* Carp. Vern.: 'Kendai'.
Kulathupuzha, November.
72. *Barbus mahecola.* Carp. Vern.: 'Poovaulen-kendai'.
Tenmalai, November.
73. *Barbus conchonius.* Carp.
Trevandrum, November.
74. *Barbus stigma.* Carp. Vern.: 'Unda-kanni'.
Karumaudi, October.
75. *Barbus vittatus.* Carp.
Tenmalai, November.
Said to be destructive to mosquito larvæ.
76. *Rasbora daniconius.* Carp. Vern.: 'Parava-kendai'.
Trevandrum, October.
77. *Rasbora nilgiriensis.* Carp. Vern.: 'Parava-kendai'.
Trevandrum, October.
78. *Rohtee bakeri.*
Kottayam, November.
79. *Barilius bakeri.*
Tenmalai, November.
80. *Danio malabaricus.* Vern.: 'Cheela-pauray'.
Parappar, November.
81. *Perilamphus laubuca.*
Vellany, February.
Not found in Southern India. *F.B.I.*
82. *Cheela boopis.*
Cape Comorin, November.

Family II. SILURIDÆ

The Cat-fishes belong to a large family of fresh-water forms, and include a few marine species (*Plotosus* and *Arius*). The majority are edible, though according to some authors, the Mahomedans do not eat them. They are coarse feeders, and thrive well in muddy water, and their maws yield isinglass. Some build nests for the reception of eggs, others, particularly the males, carry the eggs within their capacious mouths and retain them there till they are hatched. The Siluroids are of world-wide distribution.

83. *Plotosus canius*. Cat-fish. Vern. : 'Vari-choongum'.
Trevandrum, September.

84. *Plotosus arab*. Cat-fish. Vern. : 'Choongum'.
Trevandrum, September.
Wounds inflicted by the dorsal and pectoral spines of these fish, are as intolerable as the sting of a scorpion.

85. *Clarias magur*. Mugger. Vern. : 'Yeri-vahlay'.
Trevandrum, April.

86. *Saccobranchus fossilis*. Scorpion-fish. Vern. : 'Theyli'.
Trevandrum, November.
The Scorpion-fish is credited with causing serious wounds, by means of the pectoral fins, resulting in blood-poisoning and gangrene, sometimes necessitating amputation of the affected limb.

87. *Wallago attu*. Cat-fish. Vern. : 'Auttu-vahlay'.
Trevandrum, November.
A cosmopolitan fish much prized for food, attaining a length of 6 feet.
The Cat-fishes are so called from the barbels which resemble the whiskers of a cat.

88. *Callichrous bimaculatus*. Dragonet. Vern. : 'Chotta-vahlay'.
Cape Comorin, November.

89. *Callichrous malabaricus*. Dragonet. Vern. : 'Manjavahlay'.
Alleppy, November.

90. *Pseudotropius sykesii*. Vern. : 'Nauy-kelithi.'
Alleppy, October.

91. *Macrones chryseus*. Cat-fish. Vern. : 'Moongil'.
Trevandrum, November.

92. *Macrones gulio*. Cat-fish. Vern. : 'Kadel-kelithi'.
Trevandrum, November.

93. *Macrones vittatus*. Cat-fish. Vern. : 'Kallen-coori'.
Sasthancotta, November.
One of the commonest of food-fishes, protected by the religious sentiments of the people at Sasthancotta, particularly in that portion of the fresh-water lagoon on the temple premises, where devotees and pilgrims feed them with rice and handle them with impunity.

94. *Macrones oculatus*. Cat-fish. Vern. : 'Theydoo'.
Alleppy, October.

95. *Macrones montanus*. Cat-fish. Vern. : 'Vari Kallen-coori'.
Trevandrum, November.

96. *Macrones malabaricus.* Cat-fish. Vern.: 'Kallen-coori'.
Quilon, August.
97. *Arius cœlatus.* Cat-fish. Vern.: 'Kelithi'.
Trevandrum, March.
98. *Arius subrostratus.* Cat-fish. Vern.: 'Theydoo'.
Trevandrum, March.
99. *Arius thalassinus.* Cat-fish. Vern.: 'Theydoo'.
Trevandrum, May.
100. *Arius falcarius.* Cat-fish. Vern.: 'Theydoo'.
Alleppy, October.
101. *Arius jatius.* Cat-fish. Vern.: 'Mooken-theydoo'.
Trevandrum, March.
102. *Arius dussumieri.* Cat-fish. Vern.: 'Kazhu-theydoo'.
Trevandrum, March.
103. *Osteogeniosus militaris.* Cat-fish. Vern.: 'Pon-kelithi'.
Cape Comorin, November.

Suborder 3. *Apodes*

Family I. ANGUILLIDÆ

Typical Eels with serpentiform bodies, some undergoing metamorphosis. The strongly compressed transparent *Leptocephalus* which for a long time had been a puzzle to naturalists, has at last been discovered to be the larval form of the Eel.

104. *Anguilla bicolor.* Fresh-water Eel. Vern.: 'Kuruttoo-vilangu'.
Trevandrum, November.
105. *Murænesox cinereus.* Marine Eel. Vern.: 'Kadel-vilangu'.
Trevandrum, November.
106. *Murænichthys schultzei.* Marine Eel. Vern.: 'Variyen-vilangu'.
Cape Comorin, November.
107. *Ophichthys orientalis.* Marine Eel. Vern.: 'Kadel-vilangu'.
Quilon, March.
108. *Ophicthys microcephalus.* Marine Eel. Vern.: 'Kadel-vilangu'.
Trevandrum, November.

Family II. MURÆNIDÆ

Of predacious habits, these fishes inhabit the tropical and subtropical seas, especially about coral reefs; some adapt themselves to a fresh-water life, others inhabit the deep sea, living in holes and crevices of rocks. They reach a length of 8 feet and weigh 60 lbs. Sometimes they become a nuisance to bathers.

109. *Muræna punctata.* Spotted Eel. Vern.: 'Pulli Anjaulay'.
Trevandrum, October.
110. *Muræna tessellata.* Marine Eel. Vern.: 'Puli Anjaulay'.
Cape Comorin, December.
111. *Muræna pseudothyrsoidea.* Marine Eel. Vern.: 'Anjaulay'.
Trevandrum, October.

112. *Muræna undulata*. Marine Eel. Vern.: 'Anjaulay'.
Cape Comorin, November.

113. *Muræna nebulosa*. Marine Eel. Vern.: 'Anjaulay'.
Cape Comorin, November.
The flesh of Marine Eels is inedible on account of its rank and disagreeable odour.

Suborder 4. *Haplomi*

Family I. SCOPELIDÆ

Pelagic or deep-sea fishes, the latter with luminous spots on the head and body. Not a favourite food-fish. A good number are extinct.

114. *Saurus myops*. Vern.: 'Naucaudi'.
Sasthancotta, November.

115. *Saurida tumbil*. Vern.: 'Kal-nama Kendai'.
Trevandrum, November.

Family II. CYPRINODONTIDÆ

These are small fresh-water fishes, with many brackish-water forms, the former being recognized by the flat head; the sexes in many instances differ, the females being larger and more beautifully coloured.

They occur in tropical America and Africa and in the Mediterranean.

116. *Haplochilus lineatus*. Vern.: 'Manathu-kanni'.
Sasthancotta, November.

117. *Haplochilus panchax*. Vern.: 'Manathu-kanni'.
Sasthancotta, November.

Suborder 5. *Catosteomi*

Family I. FISTULARIIDÆ

A single genus, comprising one species, found in the back-waters of the seas of India. Body elongated, snout long and tubiform, ending in a narrow mouth, set with minute villiform teeth.

The flesh is excellent and the fish is otherwise known as Flute-mouth, Sea-snipe or Tobacco-pipe Fish.

118. *Fistularia serrata*. Flute-mouth. Vern.: 'Kolauchi'.
Trevandrum, January.

Family II. AMPHISILIDÆ

An exception among fishes, for the fact that the body of this fish is much compressed and enclosed in a transparent shell of bony armour, which is fused with the endoskeleton. The snout is elongated and tubiform, ending in a toothless mouth.

119. *Amphisile scutata*. Needle-fish.
Trevandrum, February.

Family III. SYNGNATHIDÆ

Pelagic fishes, living in weedy rock-pools of the sea-shore. Body protected by an exoskeleton of bony rings. Snout much produced, tubiform with the mouth terminal.

120. *Syngnathus*. sp., Pipe-fish.
Cape Comorin, December.

121. *Hippocampus guttulatus*. Sea-horse. Vern.: 'Kadel-kuthiray'
Trevandrum, June.
The tail is destitute of a fin and is prehensile, being used for coiling round sea-weeds.
The name of the fish is suggested by the resemblance of the body to the model of the knight in chess. They swim with the body vertical. Found in warm seas.

Suborder 6. *Percesoces*

Family I. SCOMBRESOCIDÆ

Carnivorous marine fishes comprising the Gar-pikes, and Flying-fishes, which are mainly herbivorous, the diet consisting of green algæ. The bones of several species, are green and remain unaltered, even after cooking, and on this account many people refuse to eat the flesh ; some are viviparous and adapt themselves to a fresh water existence. They occur in the tropical and temperate seas including the Mediterranean.

122. *Belone melanostigma*. Gar-pike. Vern.: 'Kolia-morel'.
Trevandrum, November.

123. *Belone choram*. Gar-pike. Vern.: 'Pilla-morel'.
Trevandrum, November.

124. *Belone liura*. Gar-pike. Vern.: 'Morel'.
Trevandrum, November.

125. *Belone strongylura*. Gar-pike. Vern.: 'Kolia-morel'.
Trevandrum, December.

126. *Belone cancila*. Gar-pike. Vern.: 'Koraulen'.
Trevandrum, November.

127. *Hemiramphus far*. Half-beak. Vern.: 'Morel'.
Trevandrum, July.
The lower jaw of the half-beaks is prolonged into a long weapon of offence.

128. *Hemiramphus xanthopterus*. Half-beak. Vern.: 'Paul-morel'.
Trevandrum, September.

129. *Hemiramphus buffonis*. Half-beak. Vern.: 'Morel'.
Trevandrum, September.

130. *Hemiramphus dispar*. Half-beak. Vern.: 'Karu-morel'.
Trevandrum, October.

131. *Exocœtus micropterus*. Flying-fish. Vern.: 'Parava-charlay'.
Trevandrum, March.

132. *Exocœtus evolans*. Flying-fish. Vern.: 'Parava-charlay'.
Trevandrum, January.

133. *Exocœtus bahiensis.* Flying-fish. Vern.: 'Parava-charlay'.
Trevandrum, January.

Family II. AMMODYTIDÆ

Of small size, these fish are gregarious and are known as Sand launces, from their habit of diving into sand and living in sandy-beaches. They are employed in baiting fish-hooks and they occur in the Atlantic, the Southern Pacific and Indian Oceans.

134. *Ammodytes callolepis.* Sand-launce.
Cape Comorin, December.

Family III. ATHERINIDÆ

The Sand-smelts are carnivorous fishes, mostly marine.
They are related to the *Sphyrænidæ* and the *Muglidæ.*

135. *Atherina forskallii.* Sand-smelt. Vern.: 'Morel-kendai,
Trevandrum, February.

Family IV. MUGILIDÆ

The Grey Mullets are edible fishes, occurring in shoals in brackish water. They are found in the tropical and temperate seas, some of them being fresh-water immigrants.

136. *Mugil cunnesius.* Grey Mullet. Vern.: 'Maula'.
Trevandrum, December.
137. *Mugil pœcilus.* Mullet. Vern.: 'Maula'.
Cape Comorin, December.
138. *Mugil amarulus.* Mullet. Vern.: 'Maula'.
Trevandrum, December.
139. *Mugil borneensis.* Mullet. Vern.: 'Maula'.
Trevandrum, December.
140. *Mugil troschellii.* Mullet.
Cape Comorin, March.

Family V. POLYNEMIDÆ

Edible marine and estuarine fishes, occurring in the seas of India and tropical Western Pacific. They easily take a bait, and are one of the chief sources of fish-maw. They are known as Topsi or Paradise-fish.

141. *Polynemus sextarius.* Mango-fish. Vern.: 'Manangu'.
Trevandrum, August.
142. *Polynemus indicus.* Paradise-fish. Vern.: 'Manangu'.
Trevandrum, August.
143. *Polynemus plebius.* Paradise-fish. Vern.: 'Manangu'.
Trevandrum, August.

Family VI. SPHYRÆNIDÆ

A small family of marine fishes of somewhat large size and extremely voracious habits. The flesh is not always edible on account of the poisonous properties developed at certain seasons. Specimens of abnormal size are injurious to people bathing.

144. *Sphyræna jello.* Barracoota. Vern.: 'Madavooli'. Trevandrum, August.
145. *Sphyræna acutipinnis.* Barracoota. Vern.: 'Madavooli'. Trevandrum, September.
146. *Sphyræna commersonii.* Barracoota. Vern.: 'Madavooli'. Trevandrum, September.
147. *Sphyræna obtusata.* Barracoota. Vern.: 'Madavooli'. Trevandrum, September.

Family VII. STROMATEIDÆ

Pelagic or deep-sea fishes, with the body oblong and compressed as in flat-fishes. They are good eating, and are found fairly common in Travancore from June to September.

148. *Stromateus sinensis.* White Pomfret. Vern.: 'Vellai Avoli'. Trevandrum, November.
149. *Stromateus niger.* Black Pomfret. Vern.: 'Karutha Avoli'.
    Trevandrum, September.
150. *Stromateus cinereus.* Pomfret. Vern.: 'Akoli'. Quilon, November.

Sold raw or salted and dried for markets.

Family VIII. OPHIOCEPHALIDÆ

A small family of fresh-water fishes occurring in shoals in tanks and rivers, and usually called '*Murrel*' or Walking fish. In the dry season, they are known to bury themselves in mud in a condition of suspended animation, or to migrate to the adjoining pieces of water during the night: The males build nests for the reception of eggs and guard over them till they are hatched. They are suitable for stocking tanks, and are agreeable food-fishes.

151. *Ophiocephalus marulius.* Snake-head. Vern.: 'Pooviral'. Trevandrum, January.
152. *Ophiocephalus leucopunctatus.* Walking-fish. Vern.: 'Pulli-viral'.
    Trevandrum, January.
153. *Ophiocephalus micropeltis.* Vern.: 'Karuvauhay'. Covalum, February.
154. *Ophiocephalus striatus.* Vern.: 'Viral'. Trevandrum, October.
155. *Ophiocephalus gachua.* Vern.: 'Para-koravai'. Kulathupuzha, November.

Family IX. ANABANTIDÆ

The Climbing Perches, possess remarkable powers of moving over land surface, and climbing trees in search of insects, which is effected by means of the spines with which their gill-covers and ventral fins are armed. Owing to the peculiar structure of the supra-branchial organ, they are very tenacious of life and can live out of water like the Ophiocephali for considerable periods.

156. *Anabas scandens.* Climbing Perch. Vern.: 'Panayeri Kendai'.
Trevandrum, February.

Suborder 7. *Acanthopterygii*

Family I. Berycidæ

The majority of the fishes of this family live at great depths and are related to the oldest Teleosteans; a good many are fossil forms.

Of the eight genera, hitherto known to be represented in India, two from Travancore contain shallow-water species.

157. *Myripristis murdjan.* Vern.: 'Manda-kann'.
Trevandrum, February.

158. *Holocentrum rubrum.* Vern.: 'Kadantha-mulli'.
Trevandrum, February.

Family II. Pempheridæ

Edible marine fishes of small size, inhabiting the tropical parts of the Pacific and Indian Oceans.

159. *Pempheris russellii.* Vern.: 'Kuthavoo'.
Trevandrum, August.

Family III. Cyphosidæ

Herbivorous fishes occurring in the Pacific and Indian Oceans. Fins covered with scales.

160. *Pimelepterus vagiensis.* Vern.: 'Sathay-meen'.
Trevandrum, October.

161. *Pimelepterus cineraceus.* Vern : 'Kandel'.
Trevandrum, October.

162. *Pimelepterus fuscus.*
Trevandrum, January.

Family IV. Nandidæ

Carnivorous marine and fresh-water fishes with a protractile mouth. The marine forms have not been recorded in Travancore, which contains, two fresh-water genera, said to be peculiar to India.

163. *Nandus marmoratus.* Vern.: 'Motahree'.
Trevandrum, January.

164. *Pristolepis fasciata.*
Alleppy, December.

165. *Pristolepis malabarica.* Vern.: 'Kalluringee'.
Cape Comorin, October.

Family V. Serranidæ

Edible marine fishes of extremely voracious habits, living in still water; sometimes ascending rivers.

166. *Serranus areolatus*. Sea-perch. Vern.: 'Pulli-kalavai'. Trevandrum, February.
167. *Serranus undulosus*. Sea-perch. Vern.: 'Kalavai'. Trevandrum, February.
168. *Serranus sonnerati*. Sea-perch. Vern.. 'Kalavai'. Cape Comorin, November.
169. *Serranus gilberti*. Sea-perch. Vern.: 'Kalavai'. Cape Comorin, November.
170. *Serranus hexagonatus*. Sea-perch. Vern.: 'Aluvay'. Cape Comorin, December.
171. *Serranus diacanthus*. Cape Comorin, November.
172. *Serranus maculatus*. Sea-perch. Vern.: 'Pulli-kalavai'. Trevandrum, October.
173. *Serranus lanceolatus*. Sea-perch. Cape Comorin, November.
174. *Priacanthus holocentrum*. Sea-perch. Vern.: 'Pasuva'. Trevandrum, October.
175. *Priacanthus indicus*. Trevandrum, November.
176. *Lates calcarifer*. Sea-perch. Vern.: 'Narimeen'. Trevandrum, November.
177. *Ambasis thomasi*. Sea-perch. Vern.: 'Mulloo-cheru'. Cape Comorin, November.
178. *Ambasis nalua*. Sea-perch. Vern.: 'Sennel'. Cape Comorin, November.
179. *Ambasis myops*. Sea-perch. Vern.: 'Kaka-sennel'. Cape Comorin, November.
180. *Ambasis gymnocephalus*. Sea-perch. Cape Comorin, November.
181. *Ambasis urotenia*. Sea-perch. Trevandrum, October.
182. *Apogon hyalosoma*. Sea-perch. Trevandrum, January.
183. *Lutjanus annularis*. Sea-perch. Vern.: 'Kalavai'. Trevandrum, October.
184. *Lutjanus rivulatus*. Sea-perch. Cape Comorin, January.
185. *Lutjanus argentimaculatus*. Sea-perch. Vern.: 'Chempalli'. Trevandrum, October.
186. *Lutjanus fulviflamma*. Sea-perch. Vern.: 'Polay'. Covalum, December.
187. *Lutjanus unimaculatus*. Sea-perch. Vern.: 'Kurumay'. Cape Comorin, January.
188. *Lutjanus johni*. Sea-perch. Trevandrum, November.
189. *Lutjanus marginatus*. Sea-perch. Covalum, December.
190. *Lutjanus quinquelinearis*. Sea-perch. Trevandrum, November.
191. *Lutjanus madras*. Sea-perch. Cape Comorin, November.

192. *Therapon theraps.* Sea-perch.
Trevandrum, July.

193. *Therapon quadrilineatus.* Sea-perch.
Trevandrum, July.

Family VI. SILLAGINIDÆ

Contains a single genus, connecting the *Serranidæ* and *Sciænidæ*.

194. *Sillago sihama.* Whiting. Vern.: 'Kizhanga meen'.
Trevandrum, October. Edible.

Family VII. SCIŒNIDÆ

Of world wide distribution, these fish ascend rivers, where they do not live permanently.

195. *Umbrina dussumieri.* Thread-fish. Vern.: 'Koray'.
Trevandrum, August.

196. *Sciæna vogleri.* Thread-fish. Vern.: 'Koray'.
Trevandrum, June.

197. *Sciæna albida.* Thread-fish. Vern.: 'Koray'.
Alleppy, December.

198. *Sciæna sina.* Thread-fish. Vern.: 'Koray'.
Trevandrum, July.

199. *Sciæna diacanthus.* Thread-fish. Vern.: 'Kathalai'.
Cape Comorin, November.

200. *Sciæna aneus.* Thread-fish. Vern.: 'Penna-meen'.
Trevandrum, July.

201. *Otolithus argenteus.*
Cape Comorin, November.

Family VIII.—GERRIDÆ

Body compressed, jaws protractile, mouth toothless. Most of the species are of small size, occurring in all tropical and subtropical seas.

202. *Gerres filamentosus.* Vern.: 'Pulli-prauchi'.
Trevandrum, March.

203. *Gerres oyena.* Vern.: 'Oodan'.
Cape Comorin, November.

204. *Gerres lucidus.* Vern.: 'Oodan'.
Trevandrum, August.

205. *Gerres limbatus.* Vern.: 'Prauchi'.
Trevandrum, August.

206. *Gerres sp.* Vern.: 'Prauchi'.
Cape Comorin, November.

207. *Equula longimanus.* Vern.: 'Kauray'.
Cape Comorin, November.

208. *Equula edentula.* Vern.: 'Saluva-kauray'.
Trevandrum, July.

209. *Equula dussumieri.* Vern.: 'Nama-kauray'.
Trevandrum, July.

210. *Equula splendens.* Vern.: 'Kauna-kauray'.
Trevandrum, February.

211. *Equula insidiatrix.* Vern.: 'Pulli-kauray'.
Trevandrum, February.
212. *Equula fasciata.* Vern.: 'Kauray'.
Trevandrum, December.
213. *Gazza equulæformis.* Vern.: 'Kauray'.
Trevandrum, February.

Family IX.—LACTARIIDÆ

Carnivorous marine shore-fishes, covered with cycloid deciduous scales. The flesh is delicious and is salted and dried in abundance.

214. *Lactarius delicatulus.* Butter-fish. Vern.: 'Kuthippu'.

Family X—PRISTIPOMATIDÆ

215. *Pristipoma maculatum* Vern.: 'Pulli-pauray'.
Trevandrum, January.
216. *Pristipoma furcatum.* Vern.: 'Vari-pauray'.
Trevandrum, October.
217. *Pristipoma dussumieri.* Vern.: 'Kuthavoo'.
Trevandrum, January.
218. *Pristipoma argenteum.* Vern.: 'Pauray'.
Cape Comorin, December.
219. *Pristipoma gouraca.* Vern.: 'Konan-koray'.
Trevandrum, July.
220. *Diagramma crassispinum.* Vern.: 'Adayameen'.
Trevandrum, November.
221. *Diagramma griseum.* Vern.: 'Adayameen'.
Trevandrum, November.
222. *Diagramma pictum.* Vern.: 'Pulli-koray'.
Trevandrum, November.
223. *Diagramma punctatum.* Vern.: 'Pulli-koray'.

Family XI.—SPARIDÆ

A widely distributed family, consisting of carnivorous and herbivorous fishes inhabiting the tropical and temperate seas.

224. *Scolopsis vosmeri.* Vern.: 'Kallen-coori'.
Colachel, March.
225. *Pagrus spinifer.* Snapper. Vern.: 'Coori'.
Cape Comorin, November.
226. *Lethrinus karwa.* Sea-bream. Vern.: 'Karuva-meen'.
Parur, July.
227. *Chrysophrys datnia.* Grey-perch. Vern.: 'Kuruthalay'.
Trevandrum, January.
228. *Chrysophrys aries.* Grey-perch. Vern.: 'Matwa'.
Trevandrum, January.
Pagrus and *Chrysophrys* are found off the Atlantic coasts of N. America, in the Mediterranean and off the coasts of India.

Family XII. MULLIDÆ

The Red-mullets are carnivorous marine fishes, mainly feeding on decayed vegetable substances. They are amongst the choicest of food-fishes and are restricted to the tropical seas.

229. *Upeneoides vittatus.* Red Mullet. Vern.: 'Chennavarai'.
Trevandrum, May.
230. *Upeneoides sulphureus.* Red Mullet. Vern.: 'Navarai'.
Trevandrum, May.
231. *Upeneoides tragula.* Red Mullet. Vern.: 'Cheeral'.
Trevandrum, May.
232. *Upeneus macronema.* Red Mullet. Vern.: 'Kal-navarai'.
Cape Comorin, January.
233. *Upeneus indicus.* Red Mullet. Vern.: 'Pon-navarai'.
Cape Comorin, January.

Family XIII. CHÆTODONTIDÆ

Carnivorous marine, estuarine and river fishes, remarkable for the beauty and variety of their colour, which is more or less protective. The diet consists of the small invertebrates of the coral groves. Not a popular food-fish.

234. *Ephippus orbis.* Vern.: 'Thavanai kauray'.
Cape Comorin, August.
235. *Scatophagus argus.*
Trevandrum, June.
236. *Chætodon vagabundus.* Bristle-teeth. Vern.: 'Manja-kuli-meen'.
Trevandrum, December.
237. *Chætodon collaris.* Bristle-teeth.
Cape Comorin, December.
238. *Heniochus macrolepidotus.* Vern.: 'Chutti-kanni'.
Trevandrum, August.
239. *Holacanthus nicobariensis.* Angel-fish. Vern.: 'Kannandi-meen.'
Trevandrum, August.
240. *Holacanthus annularis.* Angel-fish. Vern.: 'Tharattai'.
Trevandrum, July.
241. *Holacanthus xanthurus.* Angel-fish. Vern.: 'Kalkasu-meen.'
Trevandrum, August.
242. *Platax teira.* Sea-bat. Vern.: 'Vavvaul-meen'.
Trevandrum, July.

The Sea-bat is remarkable for the height and breadth of its body. It occurs in the Red Sea and the Indian and Pacific Oceans; the flesh is excellent. It is found fossil in the tertiary of Monte Bolca in Northern Italy.

Family XIV. DREPANIDÆ

A family of Scombroid fishes, related to the *Chætodontidæ* from which, it is distinguished by the falciform elongate pectoral fin.

243. *Drepane punctata.* Vern.: 'Payinthi-meen'.
Trevandrum, July.

Family XV. ACANTHURIDÆ

Mostly herbivorous fishes, living in shoals among coral reefs. The skin is rough and leathery, and there is a short spine situated

on either side of the tail by means of which the fish is capable of inflicting a deep cut on the hands of imprudent persons.

244. *Zanclus cornutus.*
Trevandrum, June.

245. *Acanthurus triostegus.* Surgeon-fish. Vern.: 'Vari-pauray'.
Cape Comorin, February.
A widely distributed species.

246. *Acanthurus gahm.* Vern.: 'Koli-meen'.
Trevandrum, July.

247. *Acanthurus celebicus.* Vern.: 'Koli-meen'.
Trevandrum, July.

248. *Naseus unicornis.* Vern.: 'Ottay-komben'.
Trevandrum, July.

Family XVI. TEUTHIDIDÆ

A group of herbivorous fishes, found in the Indian and Pacific Oceans, among coral reefs.

249. *Teuthis java.* Vern.: 'Polay'.
Trevandrum, May.

250. *Teuthis nebulosa.*
Cape Comorin, December.

251. *Teuthis marmorata.*
Cape Comorin, December.

252. *Teuthis oramin.*
Trevandrum, December.

Family XVII. OSPHROMENIDÆ

Fresh-water fishes, which have much in common with the *Anabantidæ* or *Ophiocephalidæ*, and like them, have the power of withstanding removal from water and breathing air for a time, owing to the presence of a supra-branchial organ.

253. *Polyacanthus cupanus.* Vern.: 'Vannanthi-meen'.
Trevandrum, February.

Family XVIII. CICHLIDÆ

A small group of fresh and brackish water fishes, restricted to lagoons and rivers. Edible.

254. *Etroplus suratensis.* Vern.: 'Chauni-kendai'.
Trevandrum, October.

255. *Etroplus maculatus.* Vern.: 'Setha-kendai'.
Trevandrum, October.

Family XIX. POMACENTRIDÆ

Gorgeously coloured carnivorous marine fishes, confined to the coral reefs, where their diet consists of the medusæ of the reefs, as also vegetable organisms. They occur throughout the tropical parts of the Indo-Pacific, and off the Atlantic coasts of tropical America.

256. *Glyphidodon sordidus.* Vern.: 'Yeru-meen'.
Trevandrum, November.

257. *Glyphidodon bonang*.
Trevandrum, February.
258. *Glyphidodon cœlestinus*.
Trevandrum, January.
259. *Glyphidodon leucogaster*.
Trevandrum, November.

Family XX. LABRIDÆ

A large family of marine fishes, partially carnivorous and partially herbivorous, of world wide distribution, and usually called the Wrasse. Teeth strong and parrot-like with the lips thick. They are all brilliantly coloured.

260. *Chœrops anchorago*. Wrasse. Vern. : 'Kili-meen'.
Trevandrum, September.
261. *Platyglossus marginatus*. Wrasse. Vern. : 'Kallurivi'.
Trevandrum, August.
262. *Platyglossus dussumieri*. Wrasse. Vern. : 'Kallurivi'.
Trevandrum, September.
263. *Novacula sp.*
Trevandrum, August.

Family XXI. SCARIDÆ

Teeth coalescent, often forming a parrot-like beak. These fish feed on vegetable matter, corals and hard-shelled molluscs. Some are edible, others, reputed poisonous. They are closely allied to the *Labridæ*.

264. *Pseudoscarus ghobban*. Parrot-wrasse. Ver. : 'Kili-meen'.
Trevandrum, September.
265. *Pseudoscarus rivulatus*. Parrot-wrasse. Vern. : 'Kili-meen'.
Trevandrum, August.

Family XXII. CARANGIDÆ

The Horse-mackerels are predaceous migratory marine fishes for the most part edible. Owing to unwholesome diet some of them develop poisonous properties. They differ from the true mackerels in having fewer vertebræ.

266. *Caranx rottleri*. Horse-mackerel. Vern. : 'Vankaday'.
Trevandrum, February.
267. *Caranx jarra*. Horse-mackerel. Vern. : 'Pauray'.
Trevandrum, August.
268. *Caranx carangus*. Horse-mackerel. Vern. : 'Pauray'.
Trevandrum, February.
269. *Caranx hippos*. Horse-mackerel. Vern. : 'Pauray'.
Trevandrum, December.
270. *Caranx sansun*. Horse-mackerel. Vern. : 'Pauray'.
Trevandrum, January.
271. *Caranx gymnosthetoides*. Horse-mackerel. Vern. : 'Pauray'.
Trevandrum, January.
272. *Caranx crumenophthalmus*. Horse-mackerel. Vern. : 'Pauray'.

Trevandrum, December.

273. *Caranx dejedaba.* Horse-mackerel. Vern.: ' Pauray '.
Trevandrum, December.

274. *Caranx affinis.* Horse-mackerel. Vern.: ' Pauray '.
Trevandrum, December.

275. *Caranx kalla.* Horse-mackerel. Vern.: ' Kalla-pauray '.
Trevandrum, December.

276. *Caranx atropos.* Horse-mackerel. Vern.: ' Thovu-pauray '.
Trevandrum, November.

277. *Caranx malabaricus.* Horse-mackerel. Vern.: ' Tholum-pauray '.
Trevandrum, December,

278. *Caranx armatus.* Horse-mackerel. Vern.: ' Pauray '.
Trevandrum, January.

279. *Caranx gallus.* Horse-mackerel. Vern.: ' Pauray '.
Trevandrum, February.

280. *Caranx ciliaris.* Horse-mackerel. Vern.: ' Malankylie '.
Trevandrum, February.

281. *Caranx nigripinnis.* Horse-mackerel. Vern.: ' Vari-pauray '.
Trevandrum, February.

282. *Caranx speciosus.* Horse-mackerel. Vern.: Puli-pauray '.
Trevandrum, February. Rare.

283. *Caranx xanthurus.* Horse-mackerel. Vern.: ' Pauray '.
Trevandrum, December.

284. *Caranx trachurus.* Horse-mackerel. Vern.: ' Koli-charlay '.
Trevandrum, February.
Not recorded in the Faunal volume.

285. *Seriolichthys bipinnulatus.* Vern.: ' Poonguzhal '.
Trevandrum, February.

286. *Chorinemus lysan* Vern.: ' Manja-pauray .
Quilon, July.
The flesh of this fish is rather dry and insipid.

287. *Chorinemus toloo.* Vern.: ' Manja-pauray '.
Trevandrum, May.

288. *Chorinemus sp.* Vern.: ' Pauray '.
Trevandrum, July.

289. *Trachynotus bailloni.* Vern.: Valayodu '.
Trevandrum, February.

290. *Trochynotus russellii.* Vern.: ' Valayodu '.
Trevandrum, July.

291. *Mene maculata.* Vern.: ' Pulli-kauray'.
Trevandrum, November.

Family XXIII Scombridæ

Active carnivorous fishes of pelagic habits, living in the open seas and comprising the true mackerels. They vary in form and color and are among the swiftest inhabitants of the sea. Some are migrants.

292. *Scomber macrolepidotus.* Mackerel. Vern.: ' Ayalay '.
Trevandrum, January.

293. *Thynuus thunnina.* Tunny. Vern.: ' Choora '.

Trevandrum, January.

The Tunny reaches a length of 10 feet, though usually it is about 2 feet. It is about the only fish known to be *warmblooded*. At times its flesh is unfit for food, due to its bad and unwholesome diet.

294. *Thynnus pelamys*. Bonito. Vern.: 'Kutti-choora'.
Trevandrum, January.

295. *Cybium guttatum*. Seir-fish. Vern.: 'Ney-meen'.
Trevandrum, August.

One of the favourite palatable staple food-fishes, most delicious when it is 1½ ft. to 2 ft. in length. It grows to 6 ft. and occurs in profusion in Travancore from August to November.

296. *Cybium commersonii*. Seir-fish. Vern: 'Mauvilasu'.
Trevandrum, January.

297. *Elacate nigra*. Vern.: 'Mothay'.
Trevandrum, October.

Family XXIV. TRICHIURIDÆ

The Hair-tails and Scabbard fishes devour their own kind. They are usually dried in the sun or salted and they occur in the W. Indies, the Atlantic and the Eastern seas from India to Japan.

298. *Trichiurus haumela*. Hair-tail. Vern.: 'Sunnambu-vahlay',
Trevandrum, June.

299. *Trichiurus savala*. Scabbard-fish. Vern.: 'Kolla-vahlay'.
Trevandrum, July.

Family XXV. HISTIOPHORIDÆ

The Sword and Spear-fishes are members of this family. Their snout is prolonged to form a formidable weapon of offence, covered with innumerable minute teeth on the outer surface.

The sword-fishes are conspicuously aggressive and attack whales and other cetaceans, which they kill by repeated thrusts of the sword. Sometimes they attack ships right through their timbers, though sheathed with copper, under a mistaken idea of their being whales, and in consequence their snouts get fixed and broken. Portions of ships thus pierced, with the broken ends *in situ*, are exhibited both in the Indian Museum, Calcutta, and the Natural History Museum, S. Kensington.

These fish are said to attain a length of from 12 ft. to 15 ft. and to weigh from 300 lbs. to 400 lbs.

The flesh is palatable and nutritious.

The sword-fishes are the largest of the bony fishes and occur in the Atlantic, the Indian and Pacific Oceans and in the Mediterranean.

300. *Histiophorus gladius*. Sword-fish. Vern.: 'Myil-kola'.
Trevandrum, November.

It is known as '*Thalay*' in Travancore.

The specimen exhibited in the Trevandrum Museum is a little over 9 ft. in length and its label bears the following legend:

'Cases of injury inflicted by this fish on unfortunate fishermen, have been treated in the General Hospital,

Trevandrum. In one of these about 9 inches of the sword, was taken from the fleshy part of the shoulder of one man, who while sitting on his catamaran had been wantonly attacked.'

301. *Histiophorus brevirostris*. Spear-fish. Vern.: 'Kattay-komben'.
Trevandrum, March.
The spear-fish differs from the sword-fish in the moderately developed dorsal fin and in the presence of spines, representing the ventral fins. The Trevandrum specimen is a painted plaster cast, reproduced from the original which was 11 ft. 9 in. long.

Family XXVI. CORYPHÆNIDÆ

The Dolphins are swift, active and extremely voracious fishes, inhabiting the high seas of the warm regions. They are remarkable for their varying hues when taken out of water and on dying, and their diet chiefly consists of flying-fishes. They occur in the Atlantic and Indian Oceans and the Mediterranean

302. *Coryphœna hippurus*. Dolphin.
Trevandrum, August.

Family XXVII. PLEURONECTIDÆ

'The Flat-fishes or Turbots live in sandy gravelly shores. The young are symmetrical in shape; but in the course of development there is a deviation from the bilateral symmetry characteristic of the Craniate Vertebrates. The body becomes laterally compressed, and the fish instead of turning over on one side, swims vertically; the eye of this side travels round till it comes close to the other eye, so that both eyes are on one side of the head. There is a distortion of the skull and a fusion of the dorsal and anal fins and there is also a blind side to the body, which is white, the upper being brown.'

Flat-fishes occur in all seas, some in estuaries and some exclusively in fresh-water. They are absent from rocky shores.

303. *Synaptura commersonianus*. Sole. Vern.: 'Nauku'.
Trevandrum, August.

304. *Synaptura orientalis*. Sole. Vern. 'Sappathi'.
Trevandrum, August.

305. *Synaptura multifasciata*. Sole. Vern.: 'Sappathi'.
Trevandrum, September.

306. *Cynoglossus dubius*. Sand-sole. Vern.: 'Sappathi'.
Trevandrum, October.

307. *Cynoglossus brevis*. Sand-sole. Vern.: 'Nauku'.
Alleppy, October.
Only in the Hoogly at Calcutta *F.B.I.*

308. *Cynoglossus brachyrhynchus*. Sand-sole. Vern.: 'Nauku'.
Trevandrum, November.

309. *Cynoglossus bengalensis*. Sand-sole. Vern.: 'Nauku'.
Trevandrum, October.

310. *Cynoglossus, sp.* Sand-sole. Vern.: 'Nauku'.
Trevandrum, October.

311. *Psettodes erumei.* Flat-fish. Vern. : ' Yerumay-nauk '.
Trevandrum, June.

312. *Pseudorhombus arsius.* Tile-fish. Vern. : ' Manangu '.
Trevandrum, June.

313. *Pseudorhombus javanicus.* Tile-fish. Vern. : ' Manangu '.
Trevandrum, September.

314. *Pseudorhombus triocellatus.* Tile-fish. Vern. : ' Pulli-manangu '.
Trevandrum, September.

315. *Plagusia marmorata.* Tile-fish. Vern. : ' Olay-manangu '.
Trevandrum, March.

Family XXVIII. Gobiidæ

A family of cosmopolitan fishes of carnivorous habits and small size, haunting rocky coasts. The pelvic fins are fused together to form a ventral suctorial disk, which enables the fish to attach itself to rocks and withstand the force of raging waves.

Some are marine, some brackish-water forms and some fresh-water immigrants.

316. *Eleotris fusca.* Goby. Vern. : ' Kuthira-vauly '.
Trevandrum, November.

317. *Eleotris butis.* Goby. Vern. : ' Kuthira-vauly '.
Trevandrum, November.

318. *Gobius giurus.* Goby. Vern. : Poonthy '.
Trevandrum, September.

319. *Gobius tentacularis.* Goby. Vern. : ' Poonthy '.
Quilon, April.

320. *Gobius striatus.* Goby. Vern. : ' Kadel Uluvay '.
Trevandrum, January.

321. *Gobius personata.* Goby. Vern. : ' Uluvay '.
Trevandrum, January.

322. *Gobius griseus.* Goby. Vern. : ' Uluvay '.
Trevandrum, May.

323. *Apocryptis bato.*
Cape Comorin, December.

Family XXIX. Echeneidæ

Edible carnivorous fishes, having the spiny dorsal fin modified into a flat laminated disk by means of which, they attach themselves to sharks, turtles and even ships, or any floating object in the sea, and profit by the refuse of the shark's dinner or offal thrown overboard.

In Cuba and Jamaica, they are used for hunting by fishermen who attach to their tail a strong cord of palm-fibre, which serves to draw them out of the water along with the prey.

324. *Echeneis naucrates.* Sucker-fish. Vern. : ' Uru-kunjoo '.
Trevandrum, October.

325. *Echeneis remora.* Sucker-fish. Vern. : ' Uru-kunjoo'.
Trevandrum, September.

Family XXX. Scorpœnidæ

Carnivorous marine fishes of viviparous habits, for the most part of small size. They have a stay or buttress across the cheek and the head which is large. The opercles are armed with poisonous spines, and in some species are transformed into poison glands.

The majority are found among coral groves and their fin-rays are curiously elongated and fringed. Some are ugly, others remarkable for their brilliant color. The young are born when about one-fourth of an inch long. The flesh is relished by the poor.

326. *Scorpæna bleekeri.* Scorpion-fish. Vern.: 'Moochay'.
Cape Comorin, February.

327. *Scorpœna armata.* Scorpion-fish. Vern.: 'Moochay'.
Cape Comorin, February.

328. *Scorpœna venosa.* Scorpion-fish. Vern.: 'Moochay
Cape Comorin, October.
Coromandel Coast of India, *F.B.I.*

329. *Pterois miles.* Vern.: 'Thoombay'.
Cape Comorin, October.

330. *Pterois russellii.* Vern.: 'Thoombay'.
Cape Comorin, October.

331. *Pterois antennata.* Vern.: 'Thoombay'.
Cape Comorin, November.

332. *Pterois zebra.* Vern.: 'Vari-thoombay'.
Cape Comorin, November.

333. *Apistus carinatus.* Vern.: 'Vari-thoombay'.
Trevandrum, September.

334. *Gymnopistus dracœna.* Vern: 'Vari-thoombay'.
Cape Comorin, February.

335. *Minous monodactyla.*
Cape Comorin, February.

Family XXXI. Platycephalidæ

The Crocodile-fishes, also known as Spiny-heads, inhabit the Indian ocean and the Western Pacific. They are bottom fishes, and their colour is protective. Only one genus, consisting of two species, is represented in Travancore.

336. *Platycephalus scaber.* Crocodile-fish. Vern.: 'Orathay'.
Trevandrum, June.

337. *Platycephalus insidiator.* Crocodile-fish. Vern.: 'Ullpathi'.
Trevandrum, June.

Family XXXI. Dactylopteridæ

The Flying Gurnards are edible fishes of elongate form, characterized by a covering of osseous keeled scales, with the head completely mailed. The pectoral fins, which are enormously developed and wing-like, are divided into two portions, and the flight of the fish, which consists of long or short leaps, is effected by the stout tail and the caudal fin. The eggs are pelagic and buoyant, and are found in almost all warm seas.

338. *Dactylopterus orientalis.* Flying Gurnard. Vern.: 'Anei-thoombi'.
Trevandrum, May.

Family XXXIII. URANOSCOPIDÆ

The Star-gazers are rapacious fishes, lying in ambush at the sea-bottom in shallow water. Eyes on top of head and capable of being raised or depressed at will. They chiefly inhabit the warm temperate seas of both hemispheres.

339. *Uranoscopus guttatus.* Star-gazer. Vern.: 'Manathu-kanni'.
Trevandrum, October.

340. *Ichthyscopus inermis.* Star-gazer. Vern.: 'Nelam-kodan-jan'.
Trevandrum, November. Not uncommon.

Family XXXIV. BLENNIIDÆ

The Blennies are shore-fishes, resembling the Gobies in size, with a covering of soft shining skin, which is either naked or scaly.

They inhabit brackish and fresh-water on rocky shores where they lurk about the crevices of rocks, among sea-weeds or under stones. Some are oviparous and some viviparous; some carnivorous, others herbivorous. They are known as jumping-fishes.

341. *Salarias steindachneri.* Blenny. Vern. 'Kallappi'.
Cape Comorin, January.

342. *Salarias kirki.* Blenny. Vern. 'Kallappi'.
Covalum, May

343. *Salarias bilitonensis.* Blenny. Vern. 'Kallappi'.
Cape Comorin, November.

344. *Salarias unicolor.*
Cape Comorin, January.

Family XXXV. BATRACHIDÆ

The Toad-fishes are creatures of sluggish habits ascending rivers. The males take care of the brood. They occur in the tropical warm seas and are not edible.

345. *Batrachus grunniens.* Toad-fish. Vern.: 'Thavala-meen'.
Cape Comorin, November.

Suborder 8. *Opisthomi*

Family I. MASTACEMBELIDÆ

The Spiny-Eels are edible carnivorous, fresh and brackish-water fishes of Southern Asia and tropical America. Dorsal and anal fins confluent.

346. *Rhynchobdella aculeata.* Thorn-backed Eel. Vern.: 'Aural'.
Trevandrum, October.

347. *Mastacembelus armatus.* Spiny Eel. Vern.: 'Kal-aural'.
Trevandrum, October.

348. *Mastacembelus guentheri.* Spiny Eel. Vern.; 'Kal-aural'.
Trevandrum, October.

Suborder 9. *Pediculati.*

Family I. ANTENNARIIDÆ

Body compressed, tumid. Dorsal fin modified into tentacles and the carpal bones, into a long arm-like appendage.

The Frog-fishes lead an inactive life on the bottom of coral reefs, where they lie in wait for prey. Their brilliant color harmonises with that of the sea-weeds, and is protective.

349. *Antennarius mummifer.* Frog-fish. Vern.: 'Moochay.'
Trevandrum, November.

Family II. MALTHIDÆ

Head and body covered with bony tubercles or spines. Spinous dorsal absent or reduced to a more or less developed tentacle, lodged in a cavity under the snout.

350. *Halieutæa stellata.* Bat-fish. Vern.: 'Vavvaul-meen'.
Trevandrum, September.

Suborder 10. *Plectognathi.*

Family I. TRIACANTHIDÆ

The body is covered with hard prickly scales, with a pair of strong erectile ventral fins. Pelvis present.

351. *Triacanthus strigilifer.* Vern. : 'Klauthi'.
Trevandrum, November.

352. *Triacanthus indicus.* Vern.: 'Komben-klauthi'.
Trevandrum, July.

Family II. BALISTIDÆ

This family comprises the File-fishes which are covered with juxtaposed movable scutes or rough spines. Teeth in jaws powerful and incisor-like, which enable the fish to break off pieces of coral or hard-shelled molluscs, on which they live.

The flesh has a rank odour and the poorer classes eat it on account of its cheapness.

The file-fishes occur around coral reefs; their rough skin is used as a substitute for sand-paper and the largest specimen is said to reach upwards of 3 feet in length.

They are found in the tropical parts of the Atlantic and the Mediterranean, beside the Indian Ocean.

353. *Balistes mitis.* File-fish.
Cape Comorin, November.

354. *Balistes viredescens.* File-fish.
Colachel, August.

355. *Balistes erythrodon.* File-fish.
Trevandrum, December.

356. *Balistes stellaris.*
Trevandrum, December.

357. *Monacanthus scriptus.*
Trevandrum, August.
This fish is covered with rhomboidal scales which are rough and so small, as to give the skin a velvety

appearance. It is herbivorous, living among coral reefs.

The flesh of many is poisonous.

Family III. ORSTRACIONTIDÆ

The Ostracion or Trunk-fish, derives its name from the angulated box-like carapace or cuirass, composed of innumerable close-fitting juxtaposed hexagonal bony plates, forming a mosaic, sometimes with two horn-like projections in front above the eyes and two on either side behind the origin of the caudal fin. They live in shallow water near the bottom in the tropical seas.

358. *Ostracion turritus*. Coffer-fish. Vern. : 'Yavay'.
Trevandrum, June.

359. *Ostracion cubicus*. Coffer-fish. Vern. : 'Yavay'.
Trevandrum, December.

360. *Ostracion nasus*. Coffer-fish. Vern. : 'Yavay'.
Cape Comorin, July.

361. *Ostracion cornutus*. Coffer-fish. Vern. : 'Yavay'.
Cape Comorin, July.

Family IV. TETRODONTIDÆ

The name Globe-fish is applied to several fishes of the genera *Tetrodon* and *Diodon*. Body short and thick, either naked or covered with scutes or spines and inflatable. The bones of the jaws are confluent, forming a parrot-like beak, and present the appearance of four large front teeth, owing to a median suture on each jaw. The skin is naked or covered with movable spines, rarely with bony plates.

They haunt coral groves and live on molluscs, and they have the power of suddenly inflating the body by swallowing air and assuming a globular form, the spines become erect and form formidable weapons. They float at the surface of the sea on their backs; the flesh of some is regarded as poisonous, though others are said to be regularly eaten.

They inhabit all the tropical and warm seas; some enter estuaries and ascend rivers. Many of the *Tetrodons* make a croaking sound.

362. *Tetrodon inermis*. Globe-fish. Vern. : 'Paythay'.
Trevandrum, December.

363. *Tetrodon lunaris*. Globe-fish. Vern. : 'Paythay'.
Trevandrum, December.

364. *Tetrodon patoca*. Globe-fish. Vern. : 'Paythay'.
Cape Comorin, February.

365. *Tetrodon unimaculatus*. Globe-fish. Vern. : 'Paythay'.
Trevandrum, February.

366. *Tetrodon stellaris*. Globe-fish. Vern. : 'Paythay'.
Cape Comorin, November.

367. *Tetrodon fluviatilis*, Globe-fish. Vern. : 'Paythay'.
Trevandrum, February.

Family V. Diodontidæ

Body covered with strong stout movable spines, which are erectile and constitute a defensive armour and an offensive weapon; these can be distinctly seen when the body is inflated. The jaws are topped with ivory-like enamel instead of teeth. They are undivided, so that there appears to be a tooth above and another below, whence the name of the family. The *Diodons* are innocent creatures until molested when they become truly formidable to deal with. In their inflated condition they are unable to swim but come to the surface, lying on their backs, and allow themselves to be carried along by the tide. They are destructive to sharks.

When they desire to revert to their normal condition, they expel the air or water from the gullet through the mouth.

368. *Diodon hystrix*. Porcupine-fish or Sea Hedge-hog. Vern.: Mulloo-paythay.
Trevandrum, March.

369. *Diodon maculatus*. Spotted Hedge-hog. Vern.: 'Pulli-paythay'.
Cape Comorin, November.

SHELLS
OF THE TROPICAL SEAS

BY

IDA COLTHURST

PART I

(*With a photo*)

Unviewed, the mysterious construction of the beautiful is continually proceeding in the sea, revealed, generally speaking, only by the scatter of shells on the shore, the architecture of myriads of creatures to whose very form we are strangers and of whose manner of life we are ignorant. What produces such exquisitely delicate objects ? And what is his wonderful natural history ?

> Did he stand at the diamond door
> Of his house in a rainbow frill ?
> Did he push when he was uncurl'd
> A golden foot or a fairy horn
> Thro' his dim water world ?

The quondam inmates of shells are known as *Mollusca* ; most wonderful and interesting creatures in their physical formation and modes of life. To the merely indifferent observer they appear to be nothing more than a mass of slimy matter, insensible to everything but touch, either burdened with a house on their backs or imprisoned between two calcareous leaves. But in reality, they have every faculty requisite for the life they lead in a watery element; they have a wonderfully constructed breathing apparatus, heart, nerves and strong muscles to hold them to their shells, eyes placed on retractile horns or mere spots in contact with a nerve; some have minute and rapidly vibrating structures called *Cilia* by means of which they move their bodies, others have tubes or syphons to take in water and eject it in the opposite direction thus enabling them to swim. Some lead an independent life, moving freely where they will, either in the water or progressing along sea-bottom by means of a slimy, strong foot; others fix themselves to foreign objects as soon as they attain adult age, or anchor themselves by spinning a set of silky threads known as a *byssus* ; others again work their way into wood or soft calcareous rocks and there imprison themselves for life. Some are carnivorous, ' devourers all, all in turn devoured ', with few but strong teeth and sometimes poison glands ; others are vegetable feeders browsing on seaweeds ;

and many have innumerable teeth arranged in rows on a long ribbon-like tongue.

Each sea-basin produces its own peculiar inhabitants, the species being controlled by geographical situation, ocean currents, structure and outline of the coast, and chiefly depth, because pressure and diminution of light are very important factors. As regards depth, there are distinct zones of life succeeding each other. First, the *Littoral* zone, the tract of beach covered and uncovered by the tides, inhabited by animals capable of bearing periodical exposure to light, air and the heat of the sun, where what may be termed the 'passive molluscs' throng; secondly, the *Laminarian* zone, which simply swarms with all marine life living in the meadows or tangle-forests of sea-weeds. Thirdly, the *Coralline* zone extending from 30 to 100 fathoms, where plants are rare but are replaced by graceful corals and their feathery allies, simulating fairy-like gardens in which a vast number of carnivorous molluscs prowl and other rainbow-hued creatures congregate to form

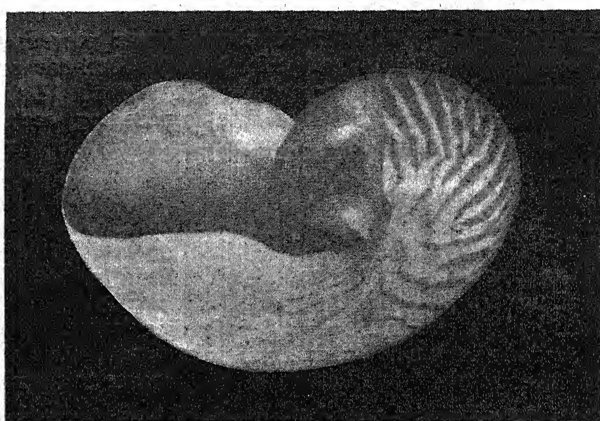
> A world of wonders, where Creation seems
> No more the works of nature but her dreams!

All the marine *Mollusca* do not burden themselves with shells, but when present they are a most conspicuous feature. In many, it is just a coiled and ornamented tube, termed a *Univalve*; in others, it is a two-hinged piece, a *Bivalve*; and in the *Chitons* it appears as light, overlapping plates. The shell is secreted by special cells in the mantle or covering skin of the animal, increasing in size by fresh deposits to its free edges, and in thickness by additions on the inner surface. The process is periodical and there are seasons of rest indicated on the shell surface by marks and ridges. The composition is *Carbonate of Lime* mixed with a horny substance which also frequently forms the outermost layer; below this is the main layer, either porcellaneous or crystalline and in certain cases prismatic; the innermost layer is often pearly, the iridiscence arising from the refraction of light by the very thin plates of its structure. The species of shells in tropical and shallow seas are brighter coloured than those confined to colder and deeper water.

Shell bearers are a vast host, and a handful of beach shingle or a pinch of ocean sediment will reveal their diversity. Their history too is that of the world, for through the ages, dead shells have built the solid portions of the earth in the ancient seas. And putting aside pearls (the most precious produce of the ocean), the *Mollusca* are of great economic value, affording man food and entering into many industries particulars of which will be mentioned in dealing with individual species.

The most highly organized of the race are the *Cephalopoda*, which, as their name implies, walk on their heads when they are not 'winnowing with giant arms the slumbering green;' 'jabbewocky,' snake-armed monsters, concerning whom fable and fancy have run wild from the days of the *Hydra* of Hercules and the *Pieuvre* of Victor Hugo to the devil fish of modern sailors. Members of this family generally have an internal, rudimentary and uncalcified shell; but the *Pearly Nautilus* (*N. Pompilius*), an inhabitant of the

Indo-Pacific Seas has a large and beautiful external one which is a fairly familiar object among the *dêbris* of the waves. The outer



THE PEARLY NAUTILUS
(*N. Pompilius.*)

surface is porcelain-like, boldly ornamented with chestnut splashes and lines, the inner one is nacreous; internally, it presents a series of chambers divided by most delicate partitions and connected by a tube which reaches to the very core and through which the animal is believed to pass a syphon in order to steady itself in the shallow outermost chamber where it lives.

The *Pearly Nautilus* is a part of Nature's oldest book, for through all the diverse marine conditions and the altering temperatures during the long periods of the deposition of the various sedimentary rocks of the globe, it has lived and still flourishes in as great abundance in our warm seas as it did in *Palæozoic* times. Although the shell is so common the animal is rarely seen, for it is one of the depth-dwellers and most plentiful in the vicinity of coral reefs. In calm weather numbers may be met with floating on the surface of the sea, with head and tentacles protruded and very little of the shell above water. They are trapped and eaten by the Pacific islanders; and in India begging pilgrims who have visited Rameswaram use the shell, which is much larger in the male, as a beggar's bowl. Dr. Holmes wrote thus fancifully in describing one, dead and broken:—

'This is the ship of pearl, which poets feign
Sails the unshadow'd main—
The venturous bark that flings
On the sweet summer wind its purpled wings.
Its webs of living gauze no more unfurl;
Wrecked is the ship of pearl!
And every chamber'd cell,
Where its dim dreaming life was wont to dwell,
As the frail tenant shap'd his growing shell,
Before thee lies reveal'd;
Its irised ceiling rent, its sunless crypt unsealed!
Year after year beheld the silent toil,

That spread his lustrous coil;
Still, as the spiral grew
He left the past year's dwelling for the new,
Stole with soft step its shining archway through,
Built up its idle door,
Stretched in his last-found home and knew the old no more!

Another shell-owning *Cephalapod* has also inspired the muse of the poets, the *Argonaut* or *Paper Nautilus*, which has been believed from very ancient times to float over the sea in its horn-shaped boat, holding up as sails a couple of distended arms, and using the others as oars.

Light as a flake of foam upon the wind,
Keel upward from the deep emerged a shell,
Shap'd like the moon ere half her horn is filled;
Fraught with young life it righted as it rose,
And mov'd at will along the yielding water.
The native pilot of this little bark
Spread to the wafting breeze a two-fold sail,
And mounted up and glided down the billow
In happy freedom.

Unfortunately, this delightful description is purely mythical. The wide membranous arms do not perform the duties of sails, but have a more prosaic utility, that of secreting the shell, while the more slender ones capture small marine creatures, especially a beautiful butterfly-shaped mollusc on which the *Argo* chiefly feeds. The shell, open and thin as paper, corrugated but only slightly coiled, is secreted by the female alone and is a receptacle for her eggs. She is much larger than the male and very beautiful, a silver mass spotted with rose and banded with blue. In the ocean the *Argonaut* progresses by violently ejecting water through a moderately long tube called the syphon, the reaction driving it in the opposite direction.

The *Nautilus* is believed to live on crabs and prawns.

Spirula also is a *Cephalapod* with a shell which is common and frequently thrown up in thousands on our shores, tiny, spirally-coiled and chambered, with the whorls widely apart; but the animal itself was rarely seen, as it is an inhabitant of deep water, until 1922 when large numbers were obtained by a Danish naturalist off the West Indies.

(*To be continued*)

REVISIONAL NOTES ON THE GENUS HELIOPHORUS (*LYCÆNIDÆ*) WITH DESCRIPTIONS OF NEW FORMS

BY

N. D. RILEY

British Museum (Natural History), South Kensington

(*With twenty-eight text-figures*)

The best attempt at a complete revision of this essentially Himalayan genus hitherto published is that by Fruhstorfer (1918). It is accompanied by photographs of the ♂ genitalia of certain species, and is based upon a study of these parts. In the light of a fuller examination of the ♂ genitalia, however, certain of his conclusions appear no longer tenable, and as, further, he misidentified several of the species concerned, the following notes, which, it is hoped, will render these very beautiful little Lycænidæ more readily and certainly identifiable, may not be out of place.

Col. Evans has recently (1927) published an excellent key of the Indian representatives of this genus, amending his earlier key (1925) after seeing the material in the British Museum and making full use of the information on synonymy that had since become available. The following notes are in the main in agreement with his revised key. Col. Evans quite rightly removes *Heliophorus* from the Theclinæ and associates it with the Coppers (*Heodes*), with which, as pointed out by Fruhstorfer, it is indeed very closely allied.

In writing these notes I have been very greatly assisted by the material placed at my disposal by Major-General Sir Harry Tytler and by Mr. G. T. Bethune-Baker. But for the loan of preparations made some years back by Mr. Bethune-Baker *Heliophorus bakeri* might yet have remained unrecognized.

KEY TO THE SPECIES OF *Heliophorus*

1. (2) Underside dull ochreous with very wide orange marginal band and 2 prominent black spots, 1 costal, the other in 1c, of hindwing ... ... *sena.*
2. (17) Underside bright ochreous, red marginal band clearly continued, less broadly than on hindwing, to apex of forewing; no prominent black spots; discal line represented in areas 2-5 of hindwing by white splashes.
3. (8) Upperside deep shining purple.
4. (5) Purple area occupying less than two-thirds of forewing; oblique subapical red bar sometimes present ... *epicles* ♂.
5. (6) Same area occupying much more than two-thirds of forewing.
6. (7) Forewing below much suffused with orange-red ... ... *ila* ♂.
7. (6) Not so, uniformly ochreous ... ... *kohimensis* ♂.
8. (3) Upperside deep brown, with red markings.
10. (13) Red markings consisting of an oblique subapical bar on forewing, and marginal band on hindwing, only.

11. (12) Underside forewing red marginal band extending to beyond vein 6 ... *epicles* ♀. subspp. *indicus*, *chinensis*, *phœnicoparyphus* and *matsumuræ*.
12. (11) Same band barely extending beyond vein 5; red markings of upperside very dull, not bright red ... *kohimensis* ♀.
13. (16) Red markings of forewing forming large circular discal patch, but not extending to base.
14. (15) Hindwing upperside without discal red scales ... ... *epicles* ssp. *sumatrensis* ♀
15. (14) With discal red scales ... ... *epicles* subspp. *epicles* and *hilima* ♀♀.
16 (13) Forewing red markings extending to base; hindwing also mostly red ... *ila* ♀.
17. (18) Underside ochreous with red marginal band of equal width on both wings; outer two-thirds of hindwing above grey-blue; tail long, white ... *kiana*.
18. (17) Underside forewing with, at most, a very narrow red marginal line; no white splashes on hindwing disc beneath; faint discal lines and lines at cell ends generally traceable on both wings, but often absent.
19. (24) Hindwing with a tooth only, no tail, at vein 2; ♂ above non-metallic blue; ♀ as usual in genus.
20. (21) Underside discal lines straight, prominent (especially on forewing), dark; forewing disc in both sexes flushed orange ... ... *oda*.
21. (20) Discal lines absent, or if faintly indicated then consisting of a series of fine arched lines most readily seen in areas 2 and 3 of forewing ... *bakeri*.
22. (23) Hindwing underside red marginal band evenly irrorated with white scales throughout. ♂ upperside forewing at least two-thirds blue ... ... *bakeri f. vernalis*.
23. (22) Hindwing marginal band not so. ♂ upperside forewing basal half only blue ... ... *bakeri f. bakeri*.
24. (19) Hindwing distinctly tailed at vein 2.
25. (50) Upperside with at least basal metallic scaling, generally for the most part some shade of brilliant metallic blue, green, bronze, or coppery—MALES.
26. (27) Upperside golden coppery ... ... *brahma* ♂.
27. (28) Upperside brassy-green ... ... *hybrida* ♂.
28. (37) Upperside silvery blue.
29. (34) Silvery blue barely extending beyond cell-end ... ... *androcles rubida* ♂.
30. (31) Underside hindwing marginal red band entirely irrorated with white ... *a. rubida f. gemma* ♂.
31. (30) Same band irrorated with white only on inner half.
32. (33) Hindwing upperside with only two narrow red lunules ... ... *androcles tytleri* ♂.
33. (32) Hindwing upperside with five wide lunules ... ... *androcles rubida* ♂.

34. (29) Silvery blue extending directly beyond cell-end for (as a rule) at least 2 mm.
35. (36) Underside marginal red band entirely and evenly irrorated with white scales ... ... *androcles coruscans f. langii* ♂.
36. (35) Same band not so irrorated ... ... *androcles coruscans* ♂
37. (44) Upperside deep blue.
38. (41) Upperside hindwing blue area extending narrowly into area 1c, not reaching marginal red lunule broadly, if at all.
39. (40) Underside hindwing marginal band entirely and evenly irrorated with white scales; no discal line either wing ... ... *androcles moorei* ♂
40. (39) Same band not so irrorated; discal lines present ... ... *androcles moorei f. scintillans* ♂.
41. (38) Upperside hindwing blue area occupying practically the whole of area 1c, and broadly reaching red marginal lunule.
42. (43) Underside hindwing marginal band entirely and evenly irrorated white scales ... ... *saphir saphir* ♂.
43. (42) Marginal band not so irrorated. A larger form ... ... *saphir f. marica* ♂.
44. (45) Upperside silvery green ... ... *androcles androcles* ♂.
45. (44) Upperside forewing at least basally frosted with green scales.
46. (47) Frosted area moderately dense, occupying approximately basal half of forewing ... ... *tamu tamu* ♂.
47. (46) Frosted area much less; sometimes represented by a few scales only.
48. (49) Hindwing upperside without marginal red lunule in area 3 ... ... *tamu kala* ♂.
49. (48) With red lunule in area 3, and sometimes also in 4 ... ... *tamu eventa* ♂.
50. (25) Upperside without metallic colouring, but with prominent red or orange markings—Females.
51. (54) Hindwing underside red marginal band evenly irrorated throughout with white scales.
52. (53) Underside without discal lines ... *saphir f. saphir* ♀.
53. (52) Discal lines present ... ... *androcles* spring or dry season forms ♀.
54. (51) Hindwing underside marginal band not so irrorated.
55. (58) Upperside marginal lunules narrow—less than 1 mm. wide in area 2; fine grey marginal line continued into area 5.
56. (57) Hindwing underside discal lines prominent, marginal red band narrow, moderately even, the white lunules bordering it inconspicuous ... *tamu* ♀.
57. (56) Discal lines almost absent, marginal band unusally broad (at least 2 mm. at narrowest point), very uneven between vein 3 and 7, white lunules large and prominent ... ... *saphir f. marica* ♀.

58. (55) Upperside marginal lunules wider, fully 1 mm. wide in area 2; grey marginal line only present in areas 1c and 2.
59. (60) Hindwing upperside marginal band ending at vein 6, and not noticeably wider there than elsewhere ... *androcles* ♀.
60. (59) Same band noticeably wider at vein 6 than elsewhere, and always continued to vein 7, sometimes further ... *brahma* ♀.

Systematic Account of the Species

Group I.—Clasps simple, without teeth or strong spines.

1. Heliophorus sena Koll. 1848

Ilerda cadma Dbl. List Lep. B.M. (nom. nud.) 1847.

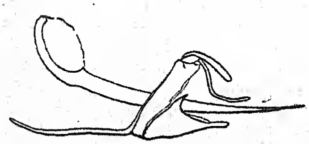
Type locality: 'In Himalaya, Massuri, Belaspur.' Obtained in both places by Hugel.

Fruhstorfer (1918) gives a very good photograph of the ♂ genitalia of this species, showing well the short, stout and bluntly terminated claspers. *H. sena* has the most simple ♂ genitalia of any species in the group; its geographical range (Chitral to Kumaon) is distinctly different from that of any other species; and it is stated to frequent more open ground than the other species and to have rather different habits. The larva feeds on *Rumex*. It is in fact a somewhat isolated form.

2. Heliophorus epicles, Godt. 1823

Type locality: Java.

Fruhstorfer (1918) gives a good figure of the genitalia of this species, taken apparently from a Formosan specimen. He is also responsible for most of the named forms.



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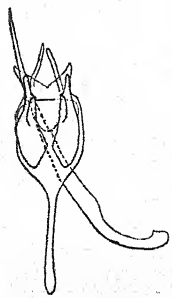

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Outline drawings of ♂ genitalia.

Fig. 1.—*Heliophorus epicles indicus*, lateral aspect, from the left.
,, 2. ,, ventral aspect.

Outline drawings of the ♂ genitalia, showing lateral and ventral aspects (Figs. 1 & 2), and made from dissections of a ♂ from Darjeeling, are given for the sake of comparison with the next three species. The long, narrow distal portion of the valve in particular should be noted.

(*a*) *H. epicles indicus*, Fruhst. 1908

Type locality: Originally given (1908) as Sikkim, Bhutan, Assam, Annam. Modified by Fruhstorfer (1912) to Sikkim to Assam, Bhutan, Kumaon and Burma; and again (1918) to Kumaon to Upper Burma. Sikkim should be taken as the type locality.

Fruhstorfer's description appears to have been based upon dry season (? early spring or late autumn) specimens from Sikkim. At the same time he described

the commonest (? wet season form) as f. *latelimbata*, and as ab. *rufonotata* males with red subapical patch on the forewing upperside. The characteristics distinguishing f. *indicus* and f. *latelimbata* apply throughout the genus. In the former, as in spring examples of other species, the marginal bands on the underside are narrow and almost completely and evenly irrorated with white scales; on the hindwing upperside the marginal band is very fully developed. In f. *latelimbata*, as in the summer broods of the other species also, the marginal red band of the upperside of the hindwing is much reduced, sometimes almost absent, but, on the underside, wide and well developed and only irrorated with white scales in its outer half.

Ab. *rufonotata* is a very common form among summer brood examples. Fruhstorfer remarks that it occurs in f. *indicus* and f. *latelimbata*, yet, although I have examined some hundreds of specimens from India, Burma and Assam, I only know of one case of its occurrence in f. *indicus*, a ♂ from Sikkim. About half the *latelimbata* examples exhibit the *rufonotata* character in Sikkim, Bhutan and Assam, but it is rarer in Burmese specimens.

H. epicles indicus occurs from Kumaon to Burma (as far south as Tenasserim at least), in the Middle Andaman, W. Siam and Yunnan. Fruhstorfer (1908) stated that it also occurred in Annam, but later (1912) referred Annamese specimens to the next subspecies.

(*b*) *H. epicles chinensis*, Fruhst. 1908

Type locality: West China.

The brief diagnosis runs: 'Separable from *indicus* by the more reduced, strongly narrowed subapical transverse red band of the forewing of the ♀.' This character holds good in most cases. To it should be added that the colour of this band is duller than in *epicles indicus*, and that the blue areas of the upperside in the male are less extensive, especially on the hindwing. It is at best however but a feebly marked race and may well prove untenable when further material comes to hand.

It is in the B.M. from Chia-ting-fu (Leech Coll.), Kiang-Si and Siao-lou (Oberthür Coll.). Draesecke (1925) records it from Omei-Shan. Fruhstorfer (1912) refers Annamese specimens to it and suggests that it also occurs in Tonkin.

In ab. *stotzneri* Draesecke (1925) the discal black spotting on the under surface is absent except for the hindwing cell-spot.

(*c*) *H. epicles matsumuræ*, Fruhst. 1908

Type locality: Formosa, L. Suisha.

Formosan males, upon which Fruhstorfer's description was based, were said by him to be larger than continental (Indian) *epicles*, to have less blue and wider dark margins. These three features are far too inconstant to distinguish them from Indian or even Chinese examples. The females are quite indistinguishable from Chinese females by their uppersides. The ground-colour of the underside, however, is much less ochreous, much more greenish, the discal black spotting greater, and the red of the marginal bands much duller vinous red than in any other subspecies, and these features should serve to differentiate *matsumuræ* (= *sakai* Mats., 1910) in both sexes; they are constant in a series of 10 ♂♂ and 6 ♀♀ derived from a number of different localities.

(*d*) *H. epicles phœnicoparyphus*, Holl. 1878

Type locality: Hainan.

Under this name should be united both Hainanese and South Chinese specimens. In the ♂ they are well characterized by the pronounced development of the red sub-apical bar, the rather light purple, and by the wide and almost complete red hindwing margins; the ♀ resembles strongly marked Indian and Burmese *epicles*, but the sub-apical red patch of the forewing is occasionally extended almost to the margin along veins 2, 3 and 4. The underside ground-colour is rich ochreous, and very free of spotting.—Hainan, Hong Kong, Ting-Wa-Shan.

(*e*) *H. epicles sumatrensis*, Fruhst. 1908

Type locality: W. Sumatra, Pad. Bovenland.

The ♀ is barely distinguishable from Javan *epicles* (see key), resembling best the E. Javan subspecies *hilima*. The ♂ differs from Javan *epicles* only in

having much less red on the forewing, or none at all; about 50 per cent of the examples examined clearly show it, the others having only a trace or none.

(*f*) *H. epicles epicles*, Godt. 1823

Type locality: Java (W. Java *teste* Frushtorfer).

The ♂ is almost identical with *phœnicoparyphus* of Hainan and S. China, the red sub-apical patch being, however, perhaps rather more diffuse, and broader, very rarely suffused blackish and inconspicuous. The ♀ is at once recognizable by the extension of the sub-apical bar to form a large orange-red rounded discal patch occupying the greater part of the wing-surface; the disc of the hindwing is also often much invaded by orange-red. On the forewing the orange area extends broadly across vein 2 almost as far as vein 1.

(*g*) *H. epicles hilima*, Fruhst. 1912

Type locality: E. Java, Mt. Tengger.

In both sexes smaller than *epicles epicles*, male otherwise the same; ♀ with reduced and rather duller orange-red patch extending only diffusely across vein 2 about centre of area 1b.

Fruhstorfer stated (1912) that the species occurs in the Celebes and that he saw it commonly on the Pic of Bonthain, but this has not yet been confirmed.

3. Heliophorus kohimensis, Tytler. 1912.

Type locality: Naga Hills, Kohima.

Several constant features serve to distinguish the males of this species from those of *H. epicles indicus*. Chief amongst these is the great extent of the violet suffusion of the upperside, and its much duller, softer tone. On the

3 4

Fig. 3.—*H. kohimensis*, lateral aspect, from the left.
,, 4. ,, ventral aspect.

underside the red marginal band of the forewing does not reach the apex so fully as in *epicles indicus*, the ground-colour is paler, and the discal lines of the hindwing (black in area 7, white in 4 and 5) are further from the marginal red band. The only apparently constant characters by which to distinguish the females are the duller red, almost orange colour of the upperside markings and the shorter (than in *epicles*) red marginal band on the underside of the forewing; in addition, the outer edge, as well as the inner, of the forewing subapical patch seems always to be sinuous, and the red lunules of the hindwing border on the upperside, though forming a continuous waved band, do not as a rule extend so far from the margin as in females of *epicles indicus*.

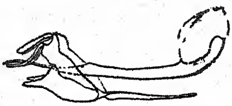
The ♂ genitalia (Figs. 3 and 4) are of the *epicles* type, but present many clear differences, mainly in the shape of the claspers, that should be readily appreciated from the accompanying drawings.

A solitary ♂ of this species was obtained at Boac-Kan, Tonkin, in January 1927, by Delacour and Lowe. Formerly it was known only from the Naga Hills, Assam, where it flies together with *epicles*.

4. HELIOPHORUS ILA, de Niceville. 1895.

H. epicles nila, Fruhst. (1918) ; *Ilerda nila*, Seitz, ix, p. 933, 1923.
Type locality : Battack Mts., N. E. Sumatra.

On the evidence of a very poor preparation of the ♂ genitalia, which he reproduced, Fruhstorfer (1918) sinks this species as a Sumatran race of *epicles*,



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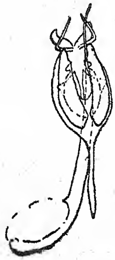

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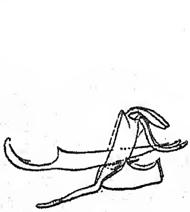
FIG. 5.—*H. ila*, lateral aspect, from the right.
,, 6. ,, ventral aspect.

misspelling the name *nila*, in which he is followed by Seitz (1923). If it is to be allied with any other species it should be with *kohimensis* Tytler rather than with *epicles* Godt., as may be judged by the resemblances of the claspers in those two species. The uppersides of the males of *kohimensis* and *ila*, in the extent of their purple areas, are extremely similar ; the female uppersides on the other hand are totally dissimilar, that of *kohimensis* being deceptively like *epicles indicus*, that of *ila* resembling an exaggerated *epicles epicles*, in which not only most of the forewing, but the greater part of the hindwing also is bright orange. *Ila* is always recognizable by the red-tinted underside, and the wide and even marginal red border of the forewing underside. It occurs commonly in Padangsche Bovenland, where *H. epicles* also flies, and in view of all the circumstances certainly is to be regarded as a good species.

5. HELIOPHORUS KIANA, Gr. Smith. 1889.

Type locality : Kina Balu, N. Borneo.

Fruhstorfer was probably right in suggesting that this aberrantly marked species is the Bornean representative of *H. epicles*, the underside markings of which are readily traceable on its underside, in spite of the whitening of the



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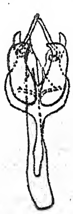

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FIG. 7.—*H. kiana*, lateral aspect, from the left.
,, 8. ,, ventral aspect.

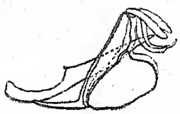
greater part of the normally red border. The development of blue on the upperside of the hindwing in the ♂, and of grey-blue in the female, marks a considerable departure from the normal appearance of *Heliophorus*, and is probably to be explained by association with the similarly coloured Theclinæ

of Mt. Kina Balu, such as *Zeltus etolus* Fab., *Sinthusa amata* Dist. and *S. skapani* Druce, *Marmessus surindra* Druce, *Virgarinia scopula* Druce and others.

Except for the expanded and truncate distal portion of the claspers, the genitalia are essentially like those of the other members of the *epicles* group of *Heliophorus*.

6. Heliophorus bakeri, Evans.

Heliophorus oda bakeri (Riley MS.), Evans, Ident. Ind. Butt. p. 158 1927.
Ilerda eos ? Doubl. List Lep. B.M. ii. p. 25, 1847 (nom. nud.).
Type locality: Murree Hills.



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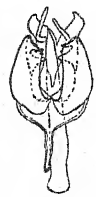

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Fig. 9.—*H. bakeri*, lateral aspect, from the left.
,, 10. ,, ventral aspect.

(*a*) Wet season form *bakeri*.

♂. Upperside, both wings rich deep blue, non-metallic, rather silky, with very wide black margins; cilia black, tipped with pale grey between the veins. *Forewing* blue area occupies the whole of cell, three-fourths of areas 1a and 1b, basal two-fifths of area 2, one-third of area 3, and is represented by a few scattered scales just beyond cell-end, *i.e.* it occupies little more than basal half of wing: its outer edge is very uneven, there being a strong projection in area 1b and another on vein 4. *Hindwing* patch leaving a black margin almost exactly 2 mm. wide all round, except along costa, where it is somewhat wider; narrow deep red lunules are present against margin in areas 1c and 2, but they are heavily obscured with black scales; hind margin slightly dentate at extremities of veins 1b—5, but no tail present. *Underside*, both wings grey-green ochreous; cilia as above. *Forewing* with a faint line at cell-end and discal line faintly present in areas 2 and 3, rarely very faintly indicated also in area 4; a prominent black tornal spot, inwardly bordered with white, and similar, narrower, progressively smaller spots in 2 and 3; a very narrow black marginal line. Hindwing with a black point in cell, another below it in 1c; a very faint line across cell-end, and a very indefinite (or absent) discal line; border deep, clear red, moderately dentate outwardly, comparatively even inwardly; white lunules bordering its inner edge prominent and edged with dusky; outer white crescents narrow and not heavily surrounded with black; a very narrow marginal black line.

♀. *Upperside*, both wings dark brown; cilia as in ♂, or slightly darker. *Forewing* with a very dark spot at cell-end, immediately followed by a rather narrow, outwardly evenly curved, inwardly angulate, crescentic orange band ending in a blunt point a little short of vein 2. *Hindwing* with a series of narrow, but strongly arched lunules in areas 1c to 4 (or 5) of a more reddish orange than band on forewing. *Underside* as in the male.

Type ♂ from Murree, 15. VIII. 86, in B.M.; ♀, Murree, VIII. 1919 in Gen. Tytler's collection.

(*b*) Dry season form *vernalis*.

♂. Differs from typical *bakeri*, as described above, as follows: *Upperside* both wings with much more extensive and brighter blue areas; cilia much paler. *Forewing* blue patch extends into costal area, reaches to within 4-5 mm. of apex, and about 1 mm. of anal angle, its outer edge evenly curved,

but slightly indented at each vein, *Hindwing* black border only 1–1·5 mm. wide except along costa ; red marginal lunules (in 1c and 2) less obscured with black, rather flattened, not strongly arched. *Underside* clearer and rather brighter ochreous, the discal lines and those closing cells virtually absent ; narrow marginal black line very faint ; cilia paler. *Forewing* anal black spot slightly smaller, those in areas 2 and 3 much smaller and mainly replaced outwardly by reddish. *Hindwing* red border densely irrorated with white, the white lunules bordering its inner edge reduced and almost devoid of their dusky edging, the outer white crescents similarly modified, very inconspicuous.

♀. Differs from the typical ♀ on the *upperside* in having the *forewing* orange subapical band slightly paler, approximately twice as broad, and just reaching vein 2. *Hindwing* marginal red lunules fused into a solid band, running up to, and ending squarely on, vein 6. inwardly comparatively even, outwardly moderately dentate at the veins. *Underside* as in the ♂. The orange band of forewing shows through slightly, but should not be confused with the orange flush in this position in *H. oda*.

Types, ♂ and ♀ in B.M. from Goorais Valley, Kashmir, June 1887.

Length of forewing : ♂ 14–17 mm.; ♀ 15-18 mm.

Localities : KASHMERE : Chitral : Utzen Nullah, VI. VII ; Tarben Nullah, 8,000 ft. Goorais Valley, VI ; Kaj Nag, 7,000 ft. VI.
PUNJAB : Murree, VIII and IX ; Dalhousie, V ; Campbellpor.
N. W. F. PROV. : Thandiani.

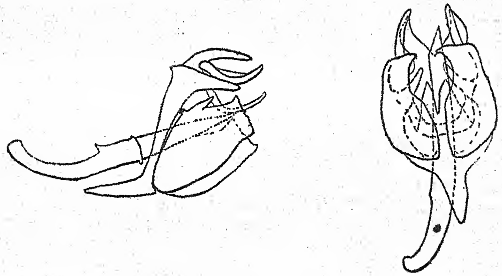
H. bakeri shows little variation apart from the seasonal differences alluded to above. It is most easily confused with *H. oda*, under which species will be found a note on the characters that serve most readily to distinguish the two. Col. Evans has recently (1927) published a brief diagnosis of this species (under the name of *H. oda bakeri*, although *bakeri* and *oda* are unquestionably distinct species), in the belief that my description had already appeared. *Bakeri* is therefore to be attributed to him.

GROUP II.—Claspers slightly or strongly inflated ; tegumen with at least a protruberance in upper half laterally, directed backwards.

7. HELIOPHORUS ODA Hew. 1865.

Type locality : ' India '. Simla should be taken, as Hewitson's specimens most probably were from that district.

♂. *Upperside*, both wings rich deep blue, non-metallic, rather silky, with wide black margins ; cilia pale grey, darker at extremities of the veins.



11 12

FIG. 11.—*H. oda*, lateral aspect from the left.
,, 12. ,, ventral aspect.

Forewing black margin narrows from about 6 mm. at apex to 1·5 at anal angle, and extends narrowly along costa ; outer edge of blue area evenly curved but somewhat indented at veins 2 and 3. *Hindwing* black margin occupies whole of costal area above vein 6, except for a small basal portion of area 6, and tapers thence strongly to margin at vein 2, continuing as a marginal black line

interrupted by the red submarginal lunules; prominent and strongly arched red submarginal lunules are present in 1c and 2 (and indicated sometimes in 3), that in 1c being noticeably expanded at anal angle; they are not obscured by black scales. *Underside*, as described for *H. bakeri* but with the following differences:—Ground-colour brighter ochreous. *Forewing* line at cell-end more sharply defined; discal line prominent, and continued to costa; tornal spot surmounted by a series of very shadowy, often reddish tinged spots, which can be traced almost to costa; margin narrowly tinged with red; the lower discal area with a distinct and extensive orange flush. *Hindwing* discal line obvious, but not so prominent as on forewing; outer two-thirds of red border irrorated with white scales, inner third clear; marginal line red; margin rather more dentate, especially at vein 2, but no tail present.

♀ *Upperside*, both wings dark brown; cilia as in ♂. *Forewing* with a dark bar at cell-end immediately followed by a broad (3 mm.) orange subapical band, the inner edge of which is almost straight but not sharply defined, in line with bar at cell-end; its outer edge runs straight from vein 7 to vein 4, where it is sharply angled to run parallel with the margin to vein 2. *Hindwing* lunular band equally wavy on both sides from anal angle to vein 4, thence broadening a little and thickening to vein 6, above which it is represented only by scattered scales. Underside as in the ♂.

Length of forewing :—♂ & ♀, 16–17 mm.

A full description is given of this species in the hope this may prevent further errors of identification in the future. *Bakeri*, *oda*, the Chinese species *saphir* and the Sikkim *moorei* are superficially very much alike in both sexes and have in the past been hopelessly confused. Examination of very long series of *bakeri* and *oda* indicates that the surest guide for their separation is furnished by the markings of the underside, particularly the discal line of the forewing. This seems quite reliable. With regard to the males, confusion may possibly arise between *oda* and *bakeri* f. *vernalis* but the arched hindwing lunule in the former is quite different from the broader flattened lunule of the latter. The width of the black border in the ♂, said by Evans to distinguish the species, only applies to the wet season form of *bakeri*; in *oda* I cannot distinguish two seasonal forms. and all the specimens I have examined have black borders of the same width as those of the spring form (*vernalis*) of *bakeri*. The female uppersides are not readily distinguishable, but it would seem that strongly arched hindwing red lunules only occur in *bakeri* in the wet season, and are then accompanied by a very small subapical forewing band, whereas in *oda*, the subapical band is invariably very large. The hindwing in *bakeri* is noticeably more rounded than in *oda*.

The ♂ genitalia (see Figs. 11 and 12) are abundantly distinct. The distal portion of the clasp in *bakeri* is evenly rounded, as in many of the species of the next group, whilst in *oda* it is expanded and squarely cut off after the fashion of *kiana*; the shape of the upper portion of the tegumen of *bakeri* is like that of *epicles*, *kohimensis*, *kiana* and *sena* in being devoid of the strong lateral lobes that characterize *oda* and the species of the *androcles* group. The ventral aspects of the claspers also emphasize the affinity of *oda* with the *androcles* group, and of *bakeri* with the *epicles* group, but the relative length of the penis in both species would associate them with the *androcles* group rather than with *epicles*.

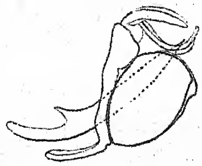
Localities: CASHMERE: Chumba State.
PUNJAB: Bushahr: Rala, VI, VIII; Kulu: Chini, VI, etc., Simla: Simla, Narkanda.
UNITED PROVINCES: Dehra Dun: 'Mussorie and Nag Tiba, only on bare spots in VI, V and X'; Garwhal; Kumaon; Naini Tal.

8. HELIOPHORUS BRAHMA, Moore. 1857.

Type locality: Darjeeling.

The brilliant metallic upperside colour of the ♂, changing from fiery red to greenish bronze serves to distinguish this species at once. The female is less easy to recognize, but has a brighter red subapical patch and hind wing band than its nearest allies, and the latter is extended practically to the apex of the wing and is more solid-looking anteriorly than in *androcles*, *tamu*, etc.

Autumn specimens from Assam (August–November) are consistently larger than those from Kumaon or Sikkim, and might be considered a good race were it not for the fact that in March–May they are replaced by a form exactly like that of Sikkim. They agree with Chinese examples in having a rather more



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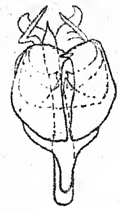

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FIG. 13.—*H. brahma*, lateral aspect from the left Teeth on distal edge of claspers not shown.

,, 14.—*H. brahma* ventral aspect.

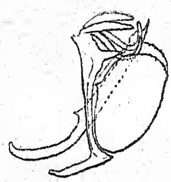
fiery colour and the marginal band of the hindwing above fairly well indicated in area 6. In examples from farther south (Ruby Mines, etc.) the red band is continued prominently into area 6 and indicated also in 7. In both Assamese and Burmese specimen there is, as a rule, a fairly prominent black spot at the anterior edge of area 7 on the underside of the hindwing, above the cell spot, and it is often produced towards the cell by a dusky line. This spot and line are rarely discernible in Himalayan examples.

The ♂ genitalia exhibit the strongly inflated claspers that characterize this and the new two species, but the upper portion of the tegumen, though moderately expanded, is devoid of the large projection to be seen in *androcles*, *tamu* and even in *oda*. Fruhstorfer (1918) gives a very good figure of them.

9. HELIOPHORUS HYBRIDA Tytler. 1912.

Type locality: Kohima, Naga Hills, Assam.

In addition to the two specimens in General Tytler's collection there is a male from Darjeeling in the British Museum, and another from the Naga Hills in Mr. Joicey's collection. Possibly also the two specimens mentioned by De



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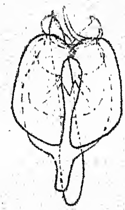

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FIG. 15.—*H. hybrida*, lateral aspectof ♂ genitalia.

,, 16. ,, ventral aspect.

Niceville (1890, p. 330) should be placed here as well. The four specimens I have seen agree exactly in external features. They are intermediate in colour and markings between Assamese *androcles* and *brahma*, the metallic colouring of the upperside being bronze, but decidedly greenish. The red marginal band on the hindwing upperside is half the width of that of *brahma*, slightly broader than in the wet season *androcles* from Assam and Darjeeling, and it extends continuously up to vein 6.

The ♂ genitalia of the single specimen examined are almost exactly intermediate between those of *androcles* and *brahma*, which will be appreciated from the figures (Figs. 15 and 16) more readily than otherwise (the profile drawing

of *brahma* is inaccurate in that it does not show the distal 'saw-edge' of the clasper). The outline of the claspers seen in profile, and of the upper halves of the tegumens should be carefully compared.

In the present state of knowledge it is not possible to decide whether these insects are hybrids, as suggested by Tytler, or not. The fact that four (possibly six) are known to exist rather militates against that view, but the precision with which *hybrida* shows the exact middle line between *brahma* and *androcles* both in external and internal characters (so far as ascertained) strongly suggests a hybrid.

10. Heliophorus androcles, Dbl. and Hew. 1852.

Type locality : Sylhet, Assam.

The various subspecies of *androcles* have been at one time or another very much confused. The W. Himalayan *coruscans* has been generally identified with the Assamese *androcles*, or with *tytleri* (see below), even Swinhoe so lately as 1911 repeating this mistake. Fruhstorfer (1918) recognized it as a good subspecies, but treated the connecting link, *moorei* of Darjeeling and Sikkim, as a distinct species, relying apparently upon a very poor preparation of the male genitalia. Many authors, including even Draesecke so recently as 1925, have regarded *moorei* as conspecific with the Chinese species *saphir*.

I regard *androcles* as consisting of five distinct sub-species, three of which have well marked seasonal forms. Some of these seasonal differences were recognized by Swinhoe (1911). Swinhoe's descriptions, so far as they go, are moderately accurate, but his figures are so misleading that I have considered it advisable to refer to them in detail (see p. 401).

(*a*) *H. androcles coruscans*, Moore

This is the subspecies of the W. Himalayas, being found at Mussooree, Kangra, Kulu, Rala, Almorah, Kali, Busahir, etc. It occurs in two well-marked seasonal forms (w.s.f. *coruscans* and d.s.f. *langii* Moore), both of which are,in the ♂. pale silvery blue on the upperside, and to be distinguished from the

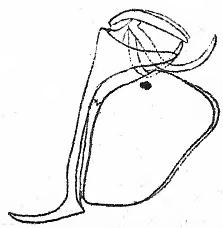

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Fig. 17.—*H. androcles coruscans*, lateral aspect of ♂ genitalia.

similarly coloured Assamese *tytleri* by the fact that this blue colour extends well beyond the cell on the forewing. The seasonal differences are those common to other species in the genus, *i.e.* w.s.f. upperside with narrow red hindwing lunules, usually in areas 1c and 2 only in ♂, and a narrow marginal red line in ♀, d.s.f. with wider and longer red marginal line in both sexes and underside red marginal band completely irrorated with white scales in both sexes in the d.s.f., only partially so in w.s.f.

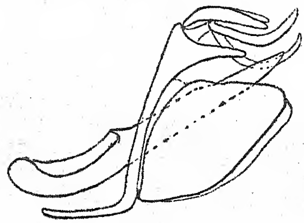
(*b*) *H. androcles moorei*, Hew.

The typical form of this subspecies, the range of which extends from Sikkim and the neighbouring region of Tibet to a point just north of Burma (Seinghku valley), appears to be excessively rare, which may account to some extent for the failure of many authors to recognize it. It is the dry season form, and it is characterized by an almost immaculate yellow underside except for the completely frosted marginal band of the hindwing ; only the unique ♂ type is known to me. The black borders on the upperside are very much wider than in any

saphir I have seen. The much commoner wet season form may be described as

f. *scintillans*, nov.

♂. *Upperside* quite deep metallic blue, the blue on the forewing extending a little beyond the cell and there sometimes expanding slightly towards costa, on the hindwing of the same extent as usual in the species ; red lunules distinctly narrow and very rarely extending at all beyond vein 3. *Underside* clear but



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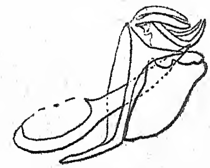

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FIG. 18.—*H. androcles moorei*, lateral aspect.
,, 19. ,, lateral aspect, another view.

rather dull ochreous,[1] with discal and discocellular lines well-developed and conspicuous ; *forewing* tornal black spot prominent and with well-marked prolongation in areas 2–3 ; *hindwing* red border not wide, irrorated with white scales only in its outer half in areas 3-6, white lunules present and clearly black-edged inwardly ; black marginal triangles moderately prominent, marginal line black, tail rather more than 1 mm. long, only basally red, then black, tipped with white.

♀. Only distinguishable from the female or typical subsp. *coruscans* by the richer ochreous tint of the underside and the frequently red-tinted discal hindwing line—characters that can hardly be appreciated except from the examination of a series of specimens.

The type ♂ and ♀ allotype from Sikkim, in B. M.

(*c*) *H. androcles rubida*, ssp. nov.

Wet season form.

♂. Upperside slightly paler than in ssp. *moorei*, almost as in ssp. *coruscans*, the blue extending a little beyond the cell-end on the forewing. Hindwing with a well-developed series of broad red lunules extending as far as vein 6. *Underside*, discal and discocellular lines present, broad, but somewhat diffuse, outer half only of marginal red band irrorated with white in areas 3–6.

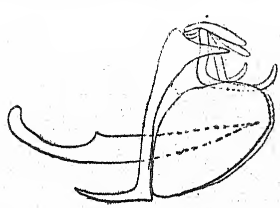

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FIG. 20.—*H. androcles rubida*, lateral aspect of ♂ genitalia

♀ Upperside subapical band broad, short ; hindwing marginal band little wider than in ♂. Underside as in ♂.

[1] The underside colour differences are most readily appreciated under ordinary electric light.

Type ♂ from Lankhaung, Upper Burma (A. E. Swann); ♀ Fengyueh-ting, C. Yunnan (H. M. B.); both in B. M.

Dry season form *gemma* nov.

♂. Hindwing red marginal band much wider (1·5 mm. at vein 6) than in the wet season form, and, on the underside, completely irrorated with white scales.

Type ♂ from Langkhaung, Upper Burma, 4,000 ft. 7.3.23 (A.E. Swann).

This little race is well characterized by possessing a complete hindwing marginal red band in both dry (spring) and wet (summer) season forms. In colour it is intermediate between *moorei* and the next subspecies. There are only 5 ♂♂ and 1 ♀ in the B.M., from a restricted area in northern Burma, and from central Yunnan, but from the latter locality there is a long series in Mr. Joicey's collection. More recently General Tytler has obtained good series from Sadon (Fort Harrison), and Htawgaw, N. Burma, both lying to the east of the 'triangle' and also from Konglu (7,800 ft., June–July 1925), which lies to the north of the triangle, a little east of Fort Hertz. All these specimens are referable to ssp. *rubida*. Though many do not show such a complete red band on the hindwing as is present in the types, its development is always greater than in ssp. *tytleri*.

(*d*) *H. androcles tytleri* ssp. nov.

Wet season form.

♂. Upperside rather light metallic sky-blue, much as in ssp. *coruscans*, but the blue hardly extending (sometimes not at all, anteriorly) beyond cell-end. Hindwing red lunules very narrow, never present above vein 3. Underside dull, dusky ochreous, the lines comparatively broad, smoky black; marginal band of 'wet' type.

♀. Resembles *rubida* ♀ most closely. Subapical band large, broad, its inner edge scarcely sinuous, reaching vein 2; hindwing marginal band widened anteriorly, thick, reaching vein 6. Underside as in ♂.

Types ♂ and ♀ from Kohima, Naga Hills, 5–6,000 ft., Sept. 1908, both in General Tytler's collection.

No dry season form is known. It appears to be common in the Naga Hills. Rarely specimens occur with the characteristic green tint of true *androcles*, serving to emphasize the close relationship of the two subspecies.

This race has been almost invariably regarded as identical with *coruscans*. Moore, which it closely resembles. The discontinuous distribution of that form then presented a difficulty which, however, is removed by recognizing that its two halves are distinct subspecies of *androcles* connected by the intermediate *moorei* and *rubida*.

It is possible that Fruhstorfer's '*H. saphir birmana*' (1918) applies to a specimen of this or the preceding subspecies. His description is based apparently upon 2 ♂♂ alleged to have come from Upper Burma and stated to be darker blue than *saphir* and to have wider blacker borders, and, on the underside, narrow red marginal bands. The last two characters are of no value; they are extremely variable judging by the series of over 100 males in the B.M. The first seems to exclude the possibility of either *rubida* or *tytleri* being Fruhstorfer's *birmana*, for both are very much *paler* than *saphir*. Fruhstorfer figures the ♂ genitalia of *H. saphir* but fails to state definitely whether they are of *saphir saphir* or of '*saphir birmana*.' The key to the plate, however, attributes them to the latter, and as they are unquestionably those of *saphir* and not those of any *androcles* form, I can only conclude that the name *birmana* rests upon a Chinese *saphir* bearing an erroneous locality label—there are unfortunately many such current in collections—for it is inconceivable that if *saphir* really exists in any part of Burma none should have found its way to the British Museum.

(*e*) *H. androcles androcles*.

Ilerda androcles viridis Evans 1912.
Type locality: Sylhet.

The males are readily recognizable by the green tint of upperside, the underside being like that of ssp. *tytleri*. The female has a rather narrow subapical band, a moderate marginal hindwing band, both of rather dull colour, and an

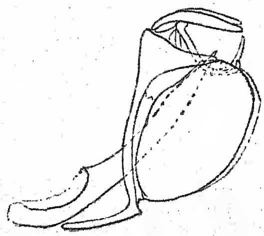

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FIG. 21.—*H. androcles androcles*, lateral aspect of ♂ genitalia.

underside like that of the male. Only the wet season form is known. Its range extends from the Khasia Hills to Mt. Victoria, Burma. Presumably it occurs at moderate altitudes only.

Genitalia. The ♂ claspers in this species are very much dilated so that it is extremely difficult in unmounted material to obtain the precisely similar views necessary for an exact comparison. No two specimens mounted in canada balsam ever present exactly the same aspect. Figs. 17 to 21 are outline drawings of the profiles of four subspecies. It will be noticed that *androcles androcles* and *androcles rubida* are perhaps the closest in the form of the clasper, but that *gemma* exhibits in the outline of the upper and distal edges a slight flattening, as compared with *androcles*, that may be regarded as an approach to *moorei*. The teeth in this region are also far less prominent than in *androcles androcles*. In *coruscans* from the other extremity of the Himalayas there is a recrudescence of the bulge on the dorsal edge of the claspers, and of other irregularities which however are hardly to be called teeth. Incidentally the close similarity of the ♂ genitalia of *coruscans* to those of *oda*, with which species *coruscans* would appear to fly, is worthy of note ; but for the possession of a large and very strong spine on the near end of the upper edge of the clasper *oda* might almost be mistaken at first sight for *coruscans*.

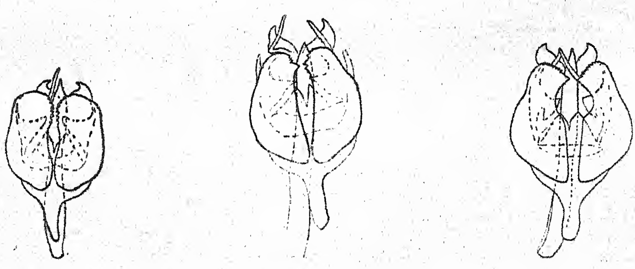

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FIG. 22.—*H. androcles coruscans*. ventral aspect of ♂ genitalia.
,, 23.—*H. androcles moorei*, ventral aspect.
,, 24.—*H. androcles tytleri*, ventral aspect.

The ventral aspects of the claspers of these subspecies (Figs. 22, 23, 24), so far as examined, also show an interesting gradation. The distal portions of the approximated edges in *coruscans* are gently curved and furnished with short blunt teeth. In *moorei* they are produced somewhat towards each other and more strongly toothed, but in *androcles tytleri* the process has gone much further, and, owing to the excavation of the adjacent edges of the claspers

beneath the tips, a quite different appearance is produced. The example illustrated in this third figure may, however, be unusually extreme; others examined do not show such a great departure from the *moorei* type of formation.

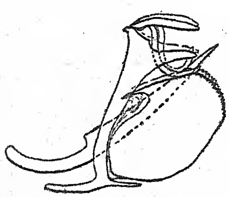
It has already been mentioned that *moorei* has very generally been associated with the Chinese *saphir*. Comparison of the outline drawings of the ♂ genitalia of the two species will make it quite clear, it is hoped, that there can be no such association in reality, as Fruhstorfer (1918) has already pointed out. But that *moorei* is only a subspecies of *androcles* is a little less easy to demonstrate. Fruhstorfer denied their affinity, but I think this must have been due to misleading preparations of the genitalia. Figs. 18 and 19 show slightly different views of the ♂ genitalia of the same specimen of *moorei*, representing a rotation of approximately 15°. If Fig. 19 of *moorei* alone were compared with, e.g. Fig 17 of *coruscans* it is excusable that they should be regarded as representing distinct species.

The modifications in the ♂ genitalia of the different subspecies appear to be of no greater order or importance than those of their external appearance and hence I consider the arrangement suggested above to be the most natural at present attainable. There is little evidence of the different subspecies overlapping, which one would expect where they met, but this is probably to be attributed in the main to the lack of material from the border regions. On the other hand they are surprisingly constant and confined to easily delimited geographical regions.

HELIOPHORUS TAMU, Koll. 1844

Ilerda viridipunctata De Nicev. 1890.
Ilerda hewitsoni Moore MS.

Hewitson (1865), Moore (1865 and 1882) and Doherty (1886) correctly identified this species, but the mistake made by de Niceville (1890) has been copied



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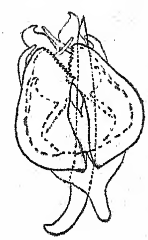

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FIG. 25.—*H. tamu*, lateral aspect of ♂ genitalia.
,, 26. ,, ventral aspect.

by all subsequent authors. Through the kindness of Dr. Rebel of the Vienna Museum I have been enabled to examine the type of Kollar's '*Polyommatus tamu*' and have found that it is unquestionably the species subsequently described by De Niceville as *viridipunctata*. De Niceville's name is certainly the better as it very well describes the frosted, powdery green appearance of the ♂ upperside, a feature that renders that sex of the species unmistakable. The female is extraordinarily like those of *H. androcles* and *H. brahma*. It is however generally duller than either species and usually larger than any of the others in any given locality where they occur together; but the best character is provided by the continuation of the fine white anteciliar line on the hindwing upperside beyond vein 3, sometimes as far as vein 6.

This species appears to inhabit the same region as *H. androcles moorei* and *H. a. tytleri*, but at slightly lower altitudes, and with an extension westwards as far as Gahrwal and eastwards to Szechuen. Three subspecies are distinguishable, the characters which are given in the key; (*a*) and (*b*) are more widely separated than (*b*) and (*c*).

(*a*) *H. tamu tamu*

Garhwal to Sikkim and Bhutan.

(*b*) *H. tamu kala* Tytler 1912

Naga Hills, Assam.

(*c*) *H. tamu eventa* Fruhst. 1918

Northern Yunnan and W. China.

f. *verna* nov.

I have seen only two specimens that can with certainty be attributed to the spring brood. Both are small males with very little green powdering on the upperside, and with the red hindwing marginal band extending to vein 6 on the upperside and uniformly irrorated with white on the underside in the manner usual to spring specimens. Both are from the Oberthür collection. One specimen, the Type, is labelled 'Thibet, Ta-ho, printemps 1895', the other 'Vallée due Tong-ho, 15 Avril—15 Mai 1893'.

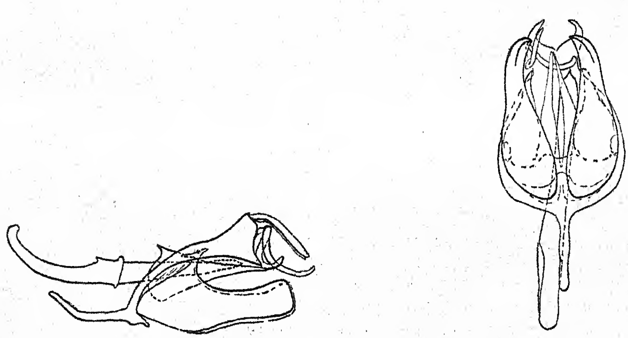
♂—ab. *rufa* nov.

A considerable proportion of the males of ssp. *eventa* show at least traces on the upperside of the forewing of an orange band like that of the female. In the Type (Tse-kou, N. Yunnan, 1895) it extends from vein 2 to vein 5, but it is seldom so well developed; usually it is a good deal duller than in the female.

The ♂ genitalia (figs. 25 and 26) exhibit a greater degree of inflation of the claspers than those of any other *Heliophorus*. They are very like those of *H. androcles androcles*, but broader, and well characterized by the strong anteriorly directed projection arising from the dorsal edge of the claspers, and the greater length of the toothed edge; the ventral aspects of the two show obvious differences in shape. The base of the tegumen projects distad, as well as basad, which is not the case in *H. androcles*.

HELIOPHORUS SAPHIR, Blanch. 1871

This extremely beautiful species is confined entirely to central and western China, so far as at present known, and would appear to be moderately common there. The male is at once recognizable by its very brilliant blue upperside and narrow costal black border. The red lunules of the hindwing upperside



27 28

FIG. 27.—*H. saphir*, lateral aspect of ♂ genitalia.
,, 28. ,, ventral aspect.

(in both sexes) are more flattened than in any *androcles* race, being in this respect reminiscent of *bakeri*. In both sexes there is an almost complete absence of discal spots on the underside. For the rest, the characters given in the key should serve to distinguish the species.

Fruhstorfer (1918) has inadvertently treated *saphir* as the wet (summer) form, *marica* Leech, as the dry season form. In fact, the opposite is correct. Leech based his *marica* on summer specimens ; Blanchard's figure clearly indicates a spring brood specimen. The identity of Fruhstorfer's '*H. saphir birmana*' has already been referred to under *androcles* (see p. 14). For the present *birmana* should be treated as synonymous with *marica*.

The ♂ genitalia, as already pointed out by Fruhstorfer, are very interesting. The relation of the saccus to the tegumen, and its length, suggest the *epicles* group ; but the strong lateral projection in the dorsal half is clearly of the *androcles* type. The shape of the claspers, seen in profile, is unique in the genus, resembling *kiana* more closely than any other species. But the most remarkable feature is presented by the production of the penis funnel to form a pair of long narrow sharp-pointed projections reaching almost to the level of the extremities of the claspers, and possibly to be considered analogous to the organs found in *Heodes* (*Chrysophanus*) and described by Bethune-Baker as *virgæ excitatæ*. I have been unable to find the 'sharp vertical double-tooth in the median part' of the clasper mentioned by Fruhstorfer. The claspers are unusually devoid of projecting surfaces or organs of any kind. In his figure the lateral projections of the upper part of the tegumen are so placed that they might be mistaken for parts of the claspers ; or on the other hand if would be easy to mistake the modified penis funnel extensions as part of the claspers.

Identification of the *Heliophorus* figured in Moore's *Lepidoptera Indica*, vol. viii.

Plate 662.

Figs. 4, 4a, 4b. *H. sena*.

Plate 663.

Fig. 1, 1b. *H. brahma* ♂.
1a, 1c. *H. androcles coruscans*. d. s. f. *langii*. The actual specimen figured is in the British Museum.
2. *H. epicles indicus*. A normal wet season ♂, f. *latilimbata* Fruhst.
2a. *H. epicles indicus*. Probably a dry season female.
2b. Underside of fig. 2.
2c. *H. epicles indicus* ab. *rufonotata*. ♂. This may be either a wet or a dry season ♂, as the aberration *rufonotata* occurs in both, though much more rarely in the latter. The extent of the red marginal band on the hindwing, however, suggests that the specimen is the rarer form. More probably it is Javan.
2d. *H. epicles indicus*. A normal wet season female (f. *latilimbatus*).

Fig. 3, 3b. *H. tamu tamu* ♂.
3a. *H. tamu tamu* ♀.

Plate 664.

Fig. 1, 1b. ♂, 1a ♀. *H. oda*. In fig. 1 the red hindwing lunules are shown less arched than usual.
1c. *H. bakeri* f. *bakeri* (wet season form) ♂.
1d. Not identifiable. Probably a small ♀ of *H. oda*.

Fig. 2, 2b. *H. androcles coruscans* ♂. The artist has quite failed to indicate the true extent of the blue area of the upperside. The specimen figured is in the British Museum.
2a, 2c. *H. oda* ♀. The specimen figured is in the British Museum.

Fig. 3, 3b. *H. androcles moorei* f. *scintillans* ♂.
3a. Probably the ♀ of 3.
3d, 3e. According to the statement by Swinhoe on p. 107 these figures should represent the dry season form of *H. androcles* ssp. *moorei* (i.e. typical *moorei*) from Sikkim. Actually, I am convinced, they are drawn from the dry season form of ssp. *coruscans* i.e. f. *langii* Moore.

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REVIEWS

1. SOME FRESHWATER FISHING IN MALAYA. By Simon and Leona Starr. 129 pages. 18 photographs and one map; obtainable from the Authors, Railbridge, Galle Face, Colombo and Messrs. Kelly and Walsh, Singapore.

The authors of this little book are apparently residents of Ceylon who paid a visit to Malaya and have narrated their fishing experiences. In their ' Foreword ' they claim to be ' original in our sport in the Malaya of to-day '. This is not the case: there are several skilful and enthusiastic fishermen in the Malay States but they do not write of their pursuit: this book can perhaps be regarded as a pioneer of Malayan fishing books but its authors are not pioneer Malayan fishermen.

Mr. and Mrs. Starr visited Singapore Island and the States of Selangor and Perak where they fished in ponds, reservoirs and rivers: and they have written a chatty account of their experiences. The information on Bait, Ground Bait, Striking, Tackle and Outfit will be useful to beginners or visitors. There are chapters on Native Methods and Tuba fishing i.e., a method of stupefying fish in pools by means of the roots of the shrub *Derris elliptica*.

We find Chapter VII the least attractive part of book and hope that the authors, in their fishing excursions, usually show more regard for the susceptibilities of native owners than they appear to have done in the case of the Chinese ' Nonia ': they had with permission fished in a pond in a private garden stocked with fish imported from China and on returning next day found the gate to the pond doubly locked. ' Not for one moment did we consider ourselves foiled. My husband climbed over the barbed wire easily, then hung my Burberry over it close to the pillar to give me support, and we were both inside and soon by the water's edge.' Then came the gardener to say that the owner did not want them there, ' we said nothing but went on fishing '. Truly ' the angling Briton is hard to deter '!

The photographs illustrate native life in the Malay Peninsula particularly in regard to methods of fishing.

We recommend the book for light reading to all interested.

F.N.C.

2. SPORT AND WILD LIFE IN THE DECCAN. By Brigadier-General R. G. Burton. Seeley, Service & Co., Ltd., 1928. 282 pages. 19 Illustrations and a Map. 21*s*.

The late General E. F. Burton, author of *Reminiscences of Sport in India* and *An Indian Olio*, served forty-four years in India prior to the year 1884; about which time our present author, one of his nine sons, all of whom entered the Indian army, came out to this country to follow his example as to big game shooting and literary work.

'Sport and Wild Life in the Deccan' will be read by all with pleasure on account of its easy literary style; with a special interest by those who have now, or have had in the past forty years, a knowledge of the country between the Satpura Hills and the Godavery river; and with additional interest by those who love the jungles, and the people and wild animals which inhabit them.

Much of the book has appeared in one form or another in previous newspaper and magazine articles. These are now brought together, with new material, to form a happy blend of wild life, military history, and big game shooting.

The author writes of those spacious days when game of all kinds was more plentiful, work less exacting, and prices and expenses about half what they are at the present time.

The young officer of the present day can, if he has the inclination and the will, do much shikar in hills and plains: but he will not do it under the pleasurable and leisurely conditions described by Brigadier-General Burton. He will not be able to post a relay of horses to take him to his previously prepared camp; to employ three or four mounted men to inspect a number of kills within a ten mile radius; to beat out two or three tigers in a day, or, indeed, beat out any tigers at all. He will have to do his annual shikar in more humble style—bullock carts and machan vigils—but do it he can; and the more he does it the better for the fuller determination of his character and the preservation of game.

So let sportsmen old and new read of the wild life and sport there used, and is still, to be had.

In Chapter IX the author discusses the interesting question of when the tiger first migrated into India. A conclusion appears to rest on the reply to the query; 'When was Ceylon separated from the mainland?.' The tiger must have migrated into India subsequent to that says the author. But is it certain that Ceylon was at any time joined to the mainland? A recent letter to the *Field* newspaper gives good reasons to show the contrary. So we are still without an answer to the question as to when the tiger first came in to India.

In the same chapter the colouration of the great felidæ is considered, the conclusion being that all were originally spotted. A spotted sabre-tooth tiger must have been a fearsome beast!

The method by which the greater carnivora hunt their prey is discussed in Chapter X. There has been much correspondence this year in the columns of the *Times* newspaper on this subject which, arising out of a book on African sport, was originated by a letter from Brigadier-General Burton. Sportsmen with Indian experience will agree with the author that it is almost wholly by hearing and sight that the hunting is done.

Remarks on the 'pooking' noise made by tigers are in accordance with the conclusions noted at page 198 of volume xxxiii, published since the issue of the book under review.

In the chapter on man-eating tigers the idea of the use of fires in scaring off wild beasts which have the will to attack is discounted; in our opinion quite rightly, and with good reason. A bear fatally wounded a sportsman in the United Provinces in 1917, first knocking

over the attendant who was walking in front with a lantern. They were returning from a machan. Last hot weather a tigress walked at night past our camp kitchen within ten feet of a cooly slumbering by the embers. Jungle animals are well acquainted with fire, and the mere keeping up of a fire is but little protection against an animal which has the will to attack.

At page 137 mention is made of a black panther having a black tongue. An eye witness informed us lately that a black panther shot some years ago in the Central Provinces had a black tongue, and a mouth the inside of which, gums and all, was entirely black. In Chapter XXIV various interesting subjects are discussed: protective colouration; sense of smell of bears; drinking habits of wild animals, etc. The conclusions of the author are in consonance with those of observers.

'Bison and Bear'. Would not the quotation at the head of the chapter have been more suitable for, say, 'Bears and Burhel'?

The photographs of animals are excellent. To how many sportsmen will they not vividly bring to memory similar rewards of successful shikar!

Times have changed. Successive decades produce books which impress that upon us. The very outlook upon sport is changing. The author is imbued with the love of nature and the wild things of the forest. To such sportsmen-naturalists as Brigadier-General Burton India owes, for many reasons, a deep debt of gratitude.

R. B.

3. SHIKAR: being Tales told by a Sportsman in India. By Lieut-Colonel C. H. Stockley, D.S.O., O.B.E., M.C., F.R.G.S., F.Z.S., 192 pages, 37 Illustrations. The Oxford University Press, 1928.

In volume xxxiii of this Journal (page 177) we reviewed a book *Big Game Shooting in the Indian Empire* by Colonel Stockley and now have the pleasure of reviewing the present volume by this experienced sportsman.

The tales told take us to the Higher Himalaya, Ladak, Kishtwar, the Trans-Indus hills, Sind, the Nilgiri Hills, Burma, and Somaliland.

As a commencement we are taken to the shooting grounds, sometimes—as the author tells us—a difficult and even dangerous journey. 'The ordinary every-day incidents of the march belong to a different world to that of city and cantonment.' How true! And what a joy it is to be on 'The Road There'. It is not the unpleasant experiences that dwell most in one's memory, as the author very truly remarks, but his journey to Kishtwar in 1911 he can never forget; and it reveals to the reader the man he is.

Reading the tale of the pursuit of the wily Tahr we again travel in Kishtwar.

> Do you know the long day's patience belly down on frozen snow,
> When the head of heads is feeding out of range?

We do! And all those who have risked life and limb over the execrable ground beloved by Tahr will enjoy every word of this tale.

The tale of the Nilgiri Tahr gives one an excellent idea of the Kundahs near Ootacamund. Beautiful hills and a perfect climate. We ourselves will profit much by this story when we go in the near future to follow in the footsteps of the author in that direction!

The Tsine of Burma is the subject of an interesting account of shooting in that country. Again we read of a grand opportunity lost for want of a cartridge. How often that happens! And it is so easy to devise means of putting on cartridges with one's clothes and so obviate being ever let down in this way. The reader may recollect that the explorer Colonel Etherton, having travelled to the far distant mountans of Central Asia—a journey of months—failed to bag a bear of a species new to him, and perhaps to science, for want of a cartridge.

The loss of that bull Tsine was not 'bad luck'. In the next chapter the author tells us tales of Luck. Nearly always is it that bad luck is merely the punishment for faulty work, that is very true and is brought home to one throughout one's shooting career. Lost opportunities seldom recur.

The Straight-horned Markhor mostly inhabits most villainous country. The tale of The Patriarch gives a vivid idea of what is entailed by pursuit of this beast in the Trans-Indus hills. Good heads of this variety of markhor are, owing to the use of high velocity rifles by hillmen of the border lands, becoming increasingly difficult to obtain.

The Sind Ibex takes one very frequently over almost as bad ground as the markhor. Large heads are still to be found; but here again the use of the high velocity rifle by the hill tribes is fast wiping out game.

Sportsmen of the younger generation desirous of following the excellent advice of Colonel Stockley in his former book as to making it one's aim to obtain as many varieties of game animals as possible, have no time to lose.

From the Sind hills we go across the sea to Somaliland, to learn something of the Lesser Kudu. 'Of all the many animals I have hunted the Lesser Kudu bears the palm for grace and beauty.' A well-told and interesting tale.

'The Tyrant' is a tale of a Himalyan black bear of truculent character. He inhabited the Kaj-i-Nag Mountains on the borders of the Vale of Kashmir.

'Quaint Beasts and Queer Habits', is a collection of interesting incidents as to birds and beasts. Very readable.

Reading 'A Mixed Bag', one is carried to the dreamland of bygone days when every Sunday and Thursday took us all out to enjoy the varied small game shooting within a day's ride, or drive, of the cantonment. Game was plentiful in those days; and still is, where the motor car is not. And where is that?

With a chapter on 'Shikaris' the book is ended in a fitting manner. For what would we do without the shikari?

There is a great charm about this book, and much for the experienced to enjoy. The reading of it, and the illustrations, will

take them back to many similar scenes and incidents. The novice will gain much by reading and re-reading all that these attractive tales contain.

R. B.

4. BIRDS AT THE NEST. By Douglas Dewar, John Lane, The Bodley Head, Ltd. 7*s*. 6*d*.

5. BIRDS AND BEASTS OF THE ROMAN ZOO. By Th. Knottnerus Meyer. Translated by Bernard Miall, George Allan and Unwin, Ltd. 16*s*.

In *Birds at the Nest* Mr. Dewar provides an interesting study of the mind of the nesting bird. He is concerned mainly with the powerful impulses which govern the behaviour of the bird during this critical period. Mr. Dewar endeavours to show that during the nesting season birds are impelled to go through their programme of activities by a blind instinct. That is to say a bird nesting for the first time builds its nest, incubates its eggs and rears its young without knowledge of the end in view and without the benefit of observation or previous experience. While the author admits the impossibility of a definite statement to the contrary, he is inclined to doubt whether a bird's knowledge in connection with its nesting activities has been inherited from its forbears. Here we think it is necessary to distinguish between those activities of a bird which depend solely on how its nervous system has been built up through heredity (activities which are common to all members of its species, for example, the plan or type of nest architecture which characterizes a particular group or genus of birds) and those activities which spring from the same inherited disposition but are at the same time influenced by experience acquired in the course of individual life. The behaviour of the bird nesting for the first time is in the former instance rendered definite through heredity, whether the experience it acquires in subsequent operations is or is not transmitted to its offspring is a question upon which naturalists are not quite agreed. Lloyd Morgan in *Instinct and Habit* tells us that animals possess a sort of 'Oral tradition.' It is due to this tradition that young Mallards observed following their wild mother in a crowded public park, where they have no enemies and come into daily contact with human beings who are not dangerous to them, behave themselves quite otherwise than in a state of complete freedom. Their behaviour it is believed is based on a tradition transmitted by the mother who has already adapted her own behaviour to altered conditions. Yet it seems fairly apparent from the many examples put forward by the author that in some respects the bird's instincts of nest-building, incubation and rearing offspring, while being founded on a heredity basis are less liable to be modified by the exercise of the inherited modes of procedure. The author has collected a comprehensive series of observations on the behaviour of birds during the nesting season, based on his own wide experience and on the experience of other naturalists. It is difficult however to believe

that a collection of anecdotes based on casual observation can afford a satisfactory solution as to whether the various activities of a bird during the nesting season are consciously or unconsciously performed. There inevitably arises the difficulty of finding a satisfactory test or criterion for deciding the presence or absence of consciousness in animal behaviour and of distinguishing how far or how much the motive of a bird's behaviour is due to inherited disposition and how much to acquired tendencies, but the author's painstaking work admittedly provides an excellent basis for further study of this very interesting though controversial subject. The truth of the matter, as Mr. Meyer indicates in his *Birds and Beasts of a Roman Zoo* lies somewhere between the extremes. Those are wrong who regard the animal as something human and those are equally wrong who conceive it merely as a living machine. It is quite conceivable that an animal's mind is not only more sensitive or more obtuse than our own but entirely different in its nature, and who can say that this is or is not so. Mr. Meyer believes that intellectual arrogance has no place in the understanding of those that stand on a lower intellectual level than ourselves. We must endeavour to step down to them and enter into their lives. In reading Mr. Meyer's book one cannot help being struck with the confidence and love Mr. Meyer displays towards his charges. It is a confidence born of happy experience due in no small measure to his innate love for and understanding of wild things, and to the sympathetic bond so firmly established between himself and the animals to whose care he has devoted so many years of his life. Particularly interesting are the author's observations on the methods adopted by various animals in giving expression to their feelings. His experience has led him to conclude that animals—the higher animals at least—possess a language of sounds which express all possible feelings—hunger, pain, contentment, joy, fear, anxiety which may be understood and interpreted in their correct meaning, as is shown by the author's experiences with the apes, the larger cats, the wolf, horse and parrot. These animals appear to have a distinct sense of right and wrong and a manifest sense of guilt, joy and grief which is not unrelated to abstract thought. Mr. Meyer readily acknowledges that the tendency to humanize the animal is almost unavoidable. But what standards have we for judging animal behaviour except in a human fashion and from a human standpoint from which alone we can make comparisons and draw conclusions ? It is inevitable that all that lies beyond the range of our ideas, beyond our understanding, must remain to us a sealed book. As Jean Henri Fabre so finely put it, the inner life of the animal must remain for ever a mystery and a secret. Mr. Meyer's book, is full of interesting and entertaining anecdotes of animals and birds in captivity which will delight the general reader and lovers of animals in particular, and which will offer a great deal that will be useful to the student of animal psychology.

S. H. P.

6. GAME BIRDS. By Douglas Dewar, with wood engravings by E. Fitch Daglish, London Chapman Hall, Ltd. 42*s*.

Mr. Douglas Dewar, a prolific begetter of books, has found justification to add to his already numerous family of volumes on Bird life. His most recent is the present sumptuous work on Game Birds—let us be more precise than the author and call it British Game Birds. In his introductory chapter he gives his personal definition of that very indefinite and elastic term ' Game '. He refuses to include under this category any song bird, any wader, except snipe and woodcock, and any water fowl save the edible ducks, swans and geese. In his opinion, no creature should be deemed game unless its habits are such as the shooting of it calls for the exercise of skill and some knowledge of its Natural History and further it affords good eating and be of such a size as to be worth plucking and cooking. Discrimination now becomes a matter of taste and Mr. Dewar's definition ought to be comprehensive enough to suit all palates! Faithful to his opinions, Mr. Dewar confines his book mainly to those birds which the more fastidious sportsman lays himself out to shoot. He develops his purpose admirably, as becomes a man with much knowledge and personal experience of what he writes, but we can hardly excuse a writer of his standing for the many errors in spelling of the scientific and proper names of various species described in this work.

For those whose interest in birds goes beyond the shooting of them, the author offers a series of interesting studies of a class of birds which to many are perhaps the most alluring. His chapters on individual species are prefaced with a summary of what is known relative to the colouration, moulting and hybridization of game birds. He introduces the reader to various problems of a controversial nature, which can only be solved by further observation and research. Here he provides a valuable field for study. For if the sportsman and the naturalist is to make a contribution to our knowlege of the lives, the habits and the history of the species which he sacrifices to his skill, he must as a preliminary know what he is to observe and the problems about which further information is needed.

The moulting of birds is a subject about which we have surprisingly little information. Every species of bird appears to change the greater part if not the whole of its feathering at least once a year. With many species the moult produces a distinctive change in the colouration of the plumage. In the opinion of many naturalists this change of colouring is brought about by the shedding and replacement of the old by new feathers. Yet it is maintained by a minority of observers that a considerable number of species assume their nuptial liveries, not by moulting alone, but also by the infusion of pigment into feathers till then uncoloured. Mr. Dewar quotes his own observations and those of other naturalists on the moulting and colour changes of the Mallard and other species in support of the latter theory. The proofs he affords in support of his claim indicate that the feathers of birds may be alive to colour transmission. The subject of the pigmentation of feathers, like that of the moult, offers a most promising field for observation.

Chapters on the Pheasants, Partridges, Quails, Geese, Ptarmigan, Blackcock, Capercailzie, Snipe, Woodcock, Mallard, Teal, Widgeon and Pochard provide the reader with studies of the exquisite beauty, wonderful structure, habits and behaviour of these birds. Short descriptions of other British waterfowl which sportsmen are likely to encounter are included in Mr. Dewar's *Key to the Wildfowl of the British Isles* which forms the subject of his concluding chapter. The book is illustrated with 23 wood-engravings by E. Fitch-Daglish.

S. H. P.

7. BULLETIN OF THE RAFFLES MUSUEM, SINGAPORE (Straits Settlements), No. I. September, 1928.

We extend a welcome to this new-comer amongst current biological journals. Hitherto the Raffles Museum, has been without a publication of its own, but the increasing output in recent years of papers on its collections, prepared by the museum staff and others has made it imperative for the museum to issue its own bulletin. Mr. Boden Kloss, Director of Museums, Straits Settlements, in an introductory note to the first number gratefully acknowledges the hospitality offered by a number of societies and institutions which have in the past placed space at the disposal of the museum in their publications. It is a hospitality which the museum still hopes to avail itself of occasionally. The Bulletin will be published as material is available. Each number will be complete in itself and will have its own pagination. It is intended, however, when sufficient numbers have been produced to form a volume of reasonable size, to issue a title page, table of contents and index. It is appropriate that the first paper in the new journal should be by Dr. Hanitsch, who retired from the Directorship of the Raffles Museum in 1919, relinquishing his charge after 25 years of service. Dr. Hanitsch's paper deals with the Blattidæ, obtained during Mr. Boden Kloss' expedition to the Mentawi Islands. The scientific results of this expedition, dealing with the Fauna and Flora of this interesting group of islands have already appeared in various publications. A list of these papers is given by Mr. Boden Kloss in his introductory note to Dr. Hanitsch's paper. Considering how little is known of the Blattid fauna of the Malaysian Subregion, it is not suprising that the 53 species obtained by the expedition include one new genus, 19 new species and one new subspecies. Notwithstanding the number of species old and new, the present collection revealed no distinctive facts of distribution. Owing to the proximity of the Mentawi Islands to Sumatra, their Blattid fauna shows a close relationship to that of the much larger Island. The Table at the end of the paper gives a list of the Blattidæ taken on the expedition with their distribution. It shows that of the 53 species obtained, 25 are common to Sumatra, 17 to Java, 22 to Borneo and 30 to the Malay Peninsula. The author believes that these figures do not indicate the true relationship but merely express the degree to which the Blattid fauna of these areas has been worked out.

S. H. P.

'WITH A CAMERA IN TIGER-LAND'

An Apology

With reference to the review by 'R.B.' of my book *With a Camera in Tiger-land*, published on pages 775 to 779 of volume xxxii, No. 4 of the Journal, the reviewer draws attention to my inaccurate remarks on the subject of the type of camera used by Mr. Marius Maxwell for animal photography in Africa.

Unfortunately I wrote the chapter in question when I was out in camp, where it is quite impossible to carry a book of the weight of Mr. Maxwell's superb volume. I thus trusted to memory and a newspaper review, which was, of course, a foolish thing to do and led me into misrepresenting Mr. Maxwell. I have referred to his book again and I find that, as 'R.B.' says, most of his pictures, like those of other animal photographers, were taken with ordinary reflex cameras, some of which are illustrated in his book.

The main point where my experience differs from Mr. Maxwell's is over the question of lens. Mr. Maxwell believes in the use of fast anastigmat lenses of such short focal lengths as 6 inches, whereas I am of the opinion that such lenses are practically useless in India, my reasons being as follows:—

(*a*) Most animals in India are very shy owing to continuous shooting and such a close approach is often almost impossible.

(*b*) Even if one does succeed in approaching sufficiently close, the subject will be almost certain to see one so that the resultant picture will represent a wild animal staring at the photographer—perhaps with a nervous or frightened expression. In my opinion, the best natural history photographs are those in which the subject is absolutely unconscious of the presence of man.

(*c*) With dangerous animals such a close approach is unnecessarily risky. Mr. Maxwell was able to cover himself with one of the famous white African hunters, who are usually dead shots. He could thus take risks which the ordinary amateur in India, often quite alone, is not justified in doing—at any rate if he be a married man.

(*d*) A 6″ lens, used head-on, gives a false perspective.

Personally I have found a 12″ Dallon fixed-focus telephoto lens quite satisfactory, although many pictures will be ruined by movement during the exposure. I think a 17″ similar lens could also be used with advantage, in cases where it is possible to get some sort of rest for the camera. I entirely agree with Mr. Maxwell as regards high power telephoto lens. I think the results they give are poor and they are so slow that they are almost impossible to use in dark forests anywhere. In India, they might be useful for the Himalayan goats and sheep and for black-buck, but that is all; and even under the best conditions the pictures they produce at full aperture—which has to be used for moving animals—leave much to be desired, both as regards sharpness and perspective.

F. W. CHAMPION,
Indian Forest Service.

AN APPEAL FOR SCORPIONS

THE EDITORS,

JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY,

Bombay.

DEAR SIRS,

I should esteem it a favour if you would interest yourself and the members of the Bombay Natural History Society in my investigation into the toxic properties of the venom of Indian scorpions.

I began the work early in 1912, but could not proceed beyond a few experiments on birds with the venoms of *Buthus tamulus* and *Palamnæus swammerdami*. There are several reasons to account for such a slow progress. Scorpions are undoubtedly plentiful in India, but one has to find them, and that supposes a degree of freedom which men of the laboratory rarely enjoy. Moreover the amount of venom given by an adult scorpion never exceeds a few milligrams; and it takes 1000 milligrams to make one gram which is the least quantity needed for a fairly complete study. Again, the glands are by no means always full; of the 22 specimens of *B. rugiscutis* which I received from Panchgani (June) only one gave a full dose of venom; of 52 *B. tamulus* (June-August) 26 had glands partly empty and 8 gave no venom at all. No wonder, then, that I should not have troubled overmuch about an enquiry which gave so little promise of a speedy and satisfactory conclusion.

The whole question of the toxicity of the venom of Indian Scorpions was, however, raised again when Mr. Prater, the Curator of the Society, reported the occurrence in the Central Provinces of several deaths from scorpion sting. I allowed myself to be persuaded to resume my enquiry and, thanks to Mr. Prater, I am now the happy possessor of the following :—

B. pachyurus	... 3·0	mgms.	average per	scorpion	=	3·0
B. rugiscutis	... 2·6	,,	,,	,,	=	0·2
B. tamulus	...43·0	,,	,,	,,	=	1·5
P. phipsoni	...16·2	,,	,,	,,	=	5·4
P. swammerdami	...85·3	,,	,,	,,	=	12·6
Isometrus europaeus 9 vesicles (= 6·7 mgms).						

All this, however, is still the proverbial drop of water in the ocean—or rather, out of it—; and I do not see any other way of getting over the difficulty, save to appeal to the members of the Bombay Natural History Society and ask them to help me to collect sufficient material for my work by sending *live* scorpions to the Curator. 'The more the merrier.'

With the hope that my appeal will meet with ready response on the part of your numerous subscribers,

I remain,
Sirs,
Yours very truly,
J. F. CAIUS.

HAFFKINE INSTITUTE,
Bombay, October 9, 1928.

EDITORIAL

THE TOXICITY OF SCORPION VENOM

Amongst the many questions which griffins—and for that matter old residents in Presidency towns—put to their friends in the mofussil when they first arrive are questions as to toxic properties of the poisons of Snakes, Scorpions and Centipedes. Are all snakes poisonous? What are the chief poisonous snakes? Are many people bitten by poisonous snakes? If bitten by a poisonous snake, what chance has a man got? These questions have been answered for several years past in this Journal and in the fascinating pages of Col. Wall's 'Poisonous Terrestrial Snakes of Our British Indian Dominions and how to Recognize Them', and our task in the editorial office has been materially lightened by the publication of the fourth edition of Col. Wall's book.

We can speak authoritatively on snakes, but can we speak so authoritatively as regards the bites of centipedes and the stings of scorpions? Up till recently the generally accepted dictum has been that children of very tender years and grown-ups in a weak condition could die from the bite of the centipede or the sting of the scorpion but that however virulent the poison of the centipede or scorpion, and however tender or susceptible the part affected, it was not fatal to a grown human being in sound health—and in the expression 'grown human' were included children of over seven or eight years of age.

That is the position which from lack of information on the subject we must still maintain as to the centipede, but as regards the scorpion we *may* have to modify our opinion and admit that the poison of certain species of scorpions may be fatal to a grown up human being, even though the latter be in sound health.

The frequent cases of mortality from scorpion sting, reported from the Central Provinces and other parts of India, led the Society in 1926 to request the Inspector-General of Hospitals in Central India to issue orders for the collection of scorpions by the staff of hospitals and dispensaries under his control. It was our intention first to discover what species occurred in the Central Provinces and then to initiate and assist in an investigation into the toxicity of the venoms of Indian scorpions in general. As a result of our request a large number of scorpions were obtained. These were identified by Mr. Pocock at the British Museum. Two of the scorpions sent to us—one from Raipur and the other from Drug, C. P.—had caused the death of two healthy children, boys of 9 and 11 years respectively. Both specimens were identified as *Buthus hendersoni*.

The toxicity of the venom varies according to species. The small red scorpions of the genus *Buthus* are known to be far more

virulent than are the large black rock scorpions (*Palmnæus*) though the latter look very much more deadly and forbidding. While the dose of poison given out by such a species as *Buthus australis* is of course infinitely smaller, its toxicity is comparable in virulence to that of the cobra.

The toxicity of the venom may also vary in the same species, this being dependent on the conditions of secretion. The first drop of venom given out by a scorpion is far more potent than succeeding drops. The scorpion carries its offensive armoury at the end of its tail. Its poison apparatus consists of a gland which terminates in a sting. The sting is perforated to allow for the delicate poison duct. It has been proved by experiment that the venom contained in the duct is far more virulent than that which is secreted in the gland itself. The venom found in the duct is a more elaborate product. It is believed to be the result of the maturation of the poison secreted in the gland. When the mature venom is exhausted the supply which follows immediately loses much of its toxic properties.

Early this year Father Caius, S. J., Bio-Chemist of the Haffkine Institute, Bombay, undertook at our request an investigation into the toxicity of the venoms of Indian scorpions, but to obtain satisfactory results large numbers of live scorpions must be collected. As Father Cauis points out in a letter which we publish on page 412 the amount of venom which may be extracted from an adult scorpion does not exceed a few milligrammes. Yet it takes 1,000 milligrammes to make one gramme which is the least quantity required for a reasonable study! The Society has been ableto add somewhat to the material now available for investigation but the quantities of venom obtained from the various species so far collected is still very limited. Numbers of live specimens from all parts of India are urgently needed for bringing the work to a successful issue. Will members of the Society, who are in a position to help, co-operate by sending us live scorpions? When you have obtained your scorpion drop him into a cigarette tin or stout wooden box and post the box to the Society's offices. Please be very careful to mark this 'Open carefully'.

An Investigation into the Composition of Salt Licks

What is the element in the earth which attracts animals of various species to areas known generally as "Salt Licks"? The obvious answer seems to be *salt*. The word "lick" was first used in America to denote a place where animals collect in numbers to lick or eat earth. It was commonly believed that animals were attracted to these spots by the salt with which the soil was impregnated. But an actual examination of the earth taken from various licks would seem to show that there is no foundation for this belief. In a paper read by Major Clive Newcomb, I.M.S., before the Far Eastern Association of Tropical Medicine in December 1927 it was stated that an analysis of seven samples of earth taken from "licks" showed there was none or very little *Sodium chloride* present. In the discussion which followed the reading of the paper the suggestion was put forward that perhaps iron was the element

sought after by the animals which visited " licks ". All the " licks " examined contained iron, yet from other considerations it was assumed that this was not the real explanation. A field of speculation is thus opened up as to what is the element which attracts animals of all species to such places. We should like to have had the opportunity of publishing Major Newcomb's paper but circumstances have prevented our being able to do so. The question is one that should interest many members of the Society whose co-operation we seek in our efforts to throw further light on an interesting problem.

We have recently received from Tavoy, Burma, samples of earth taken from two " licks ". The two samples are as unlike as they could be. One of them is an ashy grey powder, perfectly homogenous in character; while the other consists almost entirely of pebbles with a little earth and organic debris. Mr. W. S. Wood who sent us these samples, writes that he came across one instance of a " lick " which appeared to him to give an indirect indication of some constituent which had a violent purging effect on the animals which visited it. Further it has been suggested by Father Caius, who is now taking up the investigation on behalf of the Society, that a knowledge of the chemical composition of " licks " might throw light on the very obscure question of earth-eating as practised by human beings the world over. There are as many as six theories to account for this practice which is known by the name of " geophagy ", but none of them are satisfactory.

For the purpose of chemical analysis at least 5 lbs. of earth taken from licks are required, and for comparative study an equal quantity of earth from an adjoining area inhabited by the animals which visit the licks. Samples of earth commonly sold in the bazaars for human consumption would also be useful in the proposed investigation. There are, we feel sure, a large number of members sufficiently interested in the subject who would be willing to help us in this inquiry. To make the investigation complete samples of earth from as many licks as possible are necessary. Samples should be labelled as to date and locality of origin and forwarded to the Honorary Secretary of the Society.

The Ringing of Migratory Birds

In the last editorial we announced our intention to carry out the ringing of birds during the present cold season with a view to assist in the solution of some of the problems relative to their migration. The Society is now supplying rings, stamped with its address, suitable for geese, duck, cranes and the larger waterfowl, and has prepared a pamphlet of instructions outlining what should be done and the manner of doing it. With the rings it is also issuing blank schedules where particulars as regards all birds ringed are to be entered. Members of the Society who are in a position to help are requested to communicate with the Honorary Secretary. So far about 3,500 rings have been sent out to people who have volunteered to assist in the scheme and it is hoped that ringing will be done during

the current season in the following areas :—Kashgar, Tibet, Siestan, Kabul, Hazara, Kashmir, Baluchistan, Sind, Bahawalpur, Punjab, Alwar, Dhar, Indore, Jaora, Patna, Nagpur, Cutch, and Madras. It will be seen that the majority of helpers are resident in Western and North-Western India. Co-operation from other areas of the Indian Empire would add completeness to what is being done, but by this we do not in the least wish to imply that we have now a sufficiency of workers in the areas indicated above. The more we have, the better, as to obtain really satisfactory results through this means, ringing must be done on a very extensive scale. What has been accomplished in the United States may serve as an example. During the period form July 1, 1923 to December 31, 1926, no less than 234, 692 birds were ringed through the agency of the State Biological Survey and 10,338 recoveries were reported.

In connection with the ringing of migratory duck we would refer to a note which appears amongst the Miscellaneous Notes in this number and which deals with migration from Denmark to Western Siberia. It will be recalled that some of the duck ringed in Dhar State, C.I. were recovered on their breeding grounds in middle Siberia.

A glance at the map which we have reproduced on page 448 shows that the breeding grounds of the duck from Dhar State and those from Denmark are practically the same. This leads one to speculate whether duck invariably visit the same winter quarters every year. Is there an occasional change? Do ducks which winter in Denmark sometimes visit India? This is another of the problems which our bird ringing scheme might help to solve. We earnestly hope that more members will take up ringing work during the present season.

English Names for Indian Butterflies

The first two volumes on Butterflies in the *Fauna of British India* series were published over 20 years ago under the authorship of Col. Bingham. Col. Bingham died before completing the third volume. The first volume has been out of print for some years. To include the discoveries of recent years and to accord with modern ideas regarding classification, etc. both volumes require revision. Under the direction of Col. H. Stephenson, C.I.E., (late I.M.S.,) of Edinburgh University, who is the general editor of the *Fauna* it has been decided to revise the present volumes on butterflies and to complete the series. The new edition will comprise five volumes, the first of which will be published in 1932. The subsequent volumes will be issued at the rate of one volume annually. The authorship has been entrusted jointly to Capt. N. D. Riley, who is in charge of the Butterflies in the British Museum, and Brigadier W. H. Evans, C.I.E., D.S.O., R.E. whose work in connection with Indian butterflies is well known to members of the Society. The introductory part will be greatly expanded and the number of woodcuts increased. As far as lies within their power, the authors hope to make the forthcoming work in every respect a complete handbook to the study of Indian butterflies. They have under consideration the assignment of English (or trivial) names

to the various species on the lines adopted by Brigadier Evans in his *Identification of Indian Butterflies* recently published by the Society. The names given in that work were in most cases arbitrary and the authors would be glad to receive suggestions through the Honorary Secretary of the Society to improve these so as to meet the wishes of collectors in India. Will members of the Society who are interested communicate with us ?

Changes in the Society's Directorate

Since the last number of the Journal was issued there have been important changes in the directorate of the Society. We have lost one President and welcomed another; we have exchanged Honorary Secretaries and Editors and we hope Mr. Sanderson will have as pleasureable a leave as the man he so ably acted for had. In Sir Leslie Wilson we had a President who was very keen on the work the Society was doing for the spread of an interest in Natural History amongst dwellers in this great city. His help and advice has been of great assistance to the staff of the Natural History Section of the Prince of Wales Museum and it is a pity that he left India before the scheme for establishing a separate wing—designed for the purpose—for the location of the Society's exhibits became an accomplished fact. In welcoming His Excellency Sir Frederick Sykes as our new President, may we express the wish that before he leaves India he will see a Natural History Museum in full working, worthy of the city of Bombay and of the Natural History Society which bears its name.

Finance

It is too early to publish in this number the financial results of the year 1928, but it may be said here that 1928 will be remembered for three main reasons. First the incorporation of the Society, second the turning of the corner in the sale of the Society's publications (we are paying our way now with all the publications so far issued) and thirdly for the proof afforded that it pays to advertise even where scientific societies are concerned—at least that one suffers if one does not. How best to advertise is not the point, but it is a point and an interesting one to note that during 1928 the staff of the Society did not have the time to devote to " booming " the Society nor to enlist in a special recruitment crusade the services of members. As a result we had fewer new members in 1928 than during the two previous years when we made special appeals and this is a setback which must be more than regained. The Society is a mutual one, the more the Society benefits the more the member benefits, and in a material age it is surely only reasonable that a scientific and non-material Society should appeal, and let us hope not in vain, to every member to do his or her best in 1929 to enrol another member. Were our membership doubled we could indeed talk !

General

We welcomed in December the Roosevelt Brothers who with Messrs. Suydam Cutting, H. Stevens and others are making a shooting

trip on behalf of the Field Museum of Natural History, Chicago, to secure if possible specimens of Schomburgk's deer (*Cervus schomburgki*) no specimen of which has been seen alive by European sportsmen for many years (we have two heads in our Museum) and the Panda. The particular Panda they are after is the Giant Panda (*Ælluropus melanoleucus*) which is believed to inhabit the mountain ranges of Szechuan north of Ta-chien-lu. It is somewhat like a diminutive bear with glossy reddish fur and a white face. It is a representative of the *Procyonidæ* of the which American racoons and our Himalayan Cat Bear are members. No living Panda has been seen by a white man. Col. F. M. Bailey tells us that when he left Batang on the China-Tibet border, he was informed that the Chinese soldiers there had a tame one. He was very sorry to have missed the opportunity of seeing a living example of this very rare animal. There is a skin and skull from Szechuan in the Royal Scottish Museum at Edinburgh and a skin in the British Museum collection.

We also welcomed Mr. Vernay, who has helped us in so many ways before and who we believe is going to help us in the future. At the moment he is helping us by the gift of 5,000 feet of edited film taken by him in the jungles of Nepal, Mysore and Burma and illustrative of the larger game animals of these countries. It is undoubtedly the finest film of its kind taken in India. After the film has been exhibited for the personal benefit of our members it is hoped to benefit the financial resources of the Society by exhibiting it to the public in the ordinary cinema halls of India.

Congratulations to Brigadier-General R. G. Burton and Lt.-Col. C. H. Stockley on their recent books on shikar and to Father Blatter and his financial godfathers on the success of his two very fine volumes on the Beautiful Flowers of Kashmir.

MISCELLANEOUS NOTES

I.—AFTER BISON AND BUFFALO IN THE HIGH SAL FORESTS

On the morning of St. Patrick's Day, 1928 I rode into my camp at Baisagaon, a place far off the beaten track to which I had been drawn by great stories of bison, buffalo, and tiger. I was met by a a little group of Gond shikaris. All Gonds are shikaris more or less. They are the aboriginal inhabitants of these Sal forests and eke out a precarious living from the produce of their fields, as much of it as is left to them by the marauding sambhar and pig. Nearly every Gond can track a bison or a buffalo through dry grassy jungle, where to the ordinary eye there is absolutely not a sign to follow. A pressed leaf or a broken blade of grass is as good as a sign post to him.

The leading shikari, Karriya, told me they had tied up four *garas* (bullocks) the preceding night in the river bed, but though a tiger's tracks were seen near by he had happened to miss my '*garas*'. This river ran due east and was joined about 3 miles from camp by another of equal size from the south. But there were fresh tracks of bison in two places in the river, one 2 miles away due west, and one 2 miles due east down stream. This was good news as I particularly wanted to get a bison. Karriya said there were also buffalo tracks at the place down stream. I decided to go out that afternoon to the upper place as a local Gond called Kuja said the tracks were of a solitary bull. I marched off at about 3 p.m. through high Sal forest, and then suddenly dipped down a steep slope into a sandy river bed. Water was lying in small pools here and there, and in the bed of the river and along the banks were patches of the coarse green grass the bison and buffalo love. After scouting along the river bed for about half a mile Kuja suddenly squatted down and pointed excitedly to what he said was a 'Burra bhari' Gaur, a great big bison. I looked and saw the horns of the animal above the high grass in the middle of the river bed, but a careful inspection through my glasses showed me that it was either a young bull or a cow, certainly not an animal to be shot. Much to the disappointment of my keen little companion we returned to camp without firing a shot. I arranged to be up next morning at 4.30 to visit the other good spot. As usual when I am looking forward to doing something in the early morning I woke up far too early. My first consciousness was of the village cocks crowing, and when I looked at my watch I found it was only 2.30. I've never known them so early before. Before going to sleep again I heard a sambhar bell in the forest about half a mile away,

and I sleepily wondered if a tiger was on the prowl and if he would find one of my *garas*. My tea was brought at 4.30 sharp, and I drank it sitting on the edge of my camp-bed, with the stars brilliant above and the trees forming a black wall 50 yards away. I was out on my way by five. We had to go about a mile along a rough cart track and then another along the bed of the river. As we marched along in single file the silver sickle of a waning moon was shining ahead through the trees, which were here so tall that they seemed to reach right up amongst the stars. Some night bird was calling at intervals, and, as we proceeded, the sky began to lighten in the east and the first peacock woke up and sent forth his mournful call over the jungles. We had to sit down and wait for a few minutes when we reached the river, here a broad expanse of dry sand, as there was a gara tied up some 500 yards away and there was not enough light to shoot if by chance we found a tiger present. However eventually we found the bullock lying happily chewing his cud, and we passed on quietly towards where thick patches of green grass invaded the river bed. Suddenly round a corner I saw a black mass standing close to the bank and while I was trying to get a clearer view, it turned up the bank into the thick forest. I cut in and had a glimpse of the black back and wide horns of a bull bison, as it went up a slope and disappeared. I followed with what I considered the best combination of speed and caution, the crackling leaves making me feel I could be heard a mile away. I topped the crest to find the grass much shorter and the jungle thinner. There was no sign of any bison, but as I went along with my double ·375 ready I was suddenly startled by a tremendous snort and the violent stamping of feet on the ground on my left front. There I saw two bull bison standing side by side about 120 yards away. Both were coal black, but one was doing all the threatening, while the other stood stock still. Neither gave a very clear shot as there were a lot of creepers and twigs between us, but feeling they would bolt at any moment I fired at the chest of the one I saw best, the silent one, intending to give it the second barrel as it swung round. Alas for human plans! The great beast swung round at the shot as expected, but my second barrel missed fire! I followed these two old veterans for miles but found no trace of blood, so I hope my first shot was a miss, due either to my not steadying my rifle against a tree, or to my bullet being deflected by a branch. I returned to camp at 10.30 feeling very annoyed with myself, and determined to take a heavy double ·577 with me next day, even if the weight should become rather a burden after 2 or 3 hours slow tracking.

On my return to camp I was greeted with the news that a tiger had attacked one of my *garas* half a mile from camp, had bitten it in the neck, and then left it. It had then had a drink near by, and gone off. This sounded mysterious and, as a tiger which had been wounded some 15 days before this was said to be still wandering in these jungles, I thought he might be responsible for this unsuccessful attack. I therefore had a hurried breakfast and went out to investigate. I found things were as reported. On the edge of the river-bed the bullock was tied about 50 yards from a small water-hole.

There were tooth marks on the back of the animal's neck and no other injury. From the tracks in the sand the assailant was a tigress or a small tiger. I had a native bed and ropes with me and had a machan tied up in a tree over-looking the kill, hoping that the tiger might revisit the place in the day time. I was up at midday and settled down comfortably with a rug, a pillow, and a book. Also a rifle, a bottle of water, and a rain coat. And luckily the last, for it had clouded over, and from one to two it rained steadily. However I and my belongings were quite dry under the rain coat draped from my shoulders like a tent. Time passed happily in reading, drowsing, and watching the birds, especially two gorgeous wood-peckers, their plumage slashed with brilliant yellow and scarlet. The jungle behind my tree rose in a steep slope above the level of my machan. At 3.30 I heard some large animal, approaching from over the top, and swinging round, I saw twenty yards away an immense bull buffalo striding towards me as if he owned the whole forest. Indeed there is no animal which would readily contest his claims. His great black horns curving outwards and upwards from his mighty head must have measured over 9 feet from tip to tip. He suddenly saw the miserable bullock tied to the tree and pulled up with a snort of surprise. At the first noise my hand had sought my rifle, but I now gently put it down—to shoot would have been murder—and waited breathlessly to see what he would do. He stared at the *gara* for a few moments, and then with a toss of his head and another snort he turned round and swung away through the heavy grass. As I saw the tips of his horns disappear I breathed a silent prayer that I might meet this worthy antagonist again on more equal terms. At dark I heard the monkeys proclaim some dangerous beast away down stream and a sambhar also gave the alarm from the same direction, so I became very hopeful. But the tiger had not turned up by 8 p.m., so I whistled up my men and went back to camp, feeling sure that there was another kill five or six hundred yards away.

Next morning I was out at 5 o'clock and started off eastwards to look for the two old bison. About a mile from camp I suddenly got a terrific whiff of something very dead, and told two of the shikaris to search round for a kill of some sort. I had an unsuccessful stalk after bison, only seeing one go off at full gallop. On my return the shikaris told me they had found half a sambhar hind which had evidently been killed two or three days before, as it was covered with maggots. Here was a clear case of a tiger preferring his meat high. I decided to sit up over the remains, but when I went out in the afternoon the vultures had finished all but a few bones, so I gave orders for a bullock to be tied on the spot, and went off again down the bison river. When I had reached a spot near where I had seen the first of the old bulls I heard a snort in the jungle on the north side of the river. I slipped up this bank about 100 yards from where the noise seemed to come and concealed myself and my men behind trees. After half an hour or so a cow bison came out through the long grass and grazed her way down into the river bed. She was followed by two other cows and two little calves. I felt there must be a bull

coming, and sure enough there he came, a fine big fellow, coal black, and in the prime of life as shown by his unbroken sharp pointed horns. I was watching the first cow who had now come along within 5 yards of my tree and seemed to feel there was something wrong, when I felt a gentle touch from the Gond behind me, and following his carefully raised finger I saw on the south bank directly opposite me a huge bull bison stroll slowly down the slope towards the herd. He was much more ponderous than the other bull and his horns spread out wider from his head. As he advanced the younger bull stepped out in the sand and with nose thrust forward and mouth open gave two or three shrill challenges. I had never heard this noise before. It was a sort of musical whine, like a small steam whistle. Then he threw up the sand in showers with his feet and advanced towards the intruder while the rest of the herd looked on with every show of great interest. The old bull came down a bit more, whereupon the other advanced up the bank and to show his strength and valour charged and knocked down two quite respectable saplings. This was too much for the veteran. He turned away from his antagonist with sad dignity, and as my foresight swung on to his massive shoulder and steadied I felt no compunction. As he fell to the shot I hoped that his spirit would soon be wandering in that jungly paradise where old age and blunted horns, and strife, and defeat would not disturb his peace.

For several minutes the other bull and his family stood transfixed with astonishment. Then a movement from me and they stampeded the way they had come. I went to the fallen giant and found his horns were very worn and splintered to within a foot of the base. They measured 65 all round from point to point, and had a 36 inch spread. I walked home with a jubilant following of Gonds, all determined like myself to go forth the next morning and find the big buffalo, if we had to spend all day in doing so. The camp was very excited at the news of my success, and I indulged in a bottle of beer to celebrate the event.

Next morning I was out again before dawn. There was a lot to arrange. Some shikaris were detailed to start searching for tracks of buffalo in the river bed from near the camp, where I had seen the big bull, on down to where I had shot the bison. Here I was to start searching with the shikaris and when joined by the first lot, pool our discoveries and decide on the plan of campaign. Some other men were detailed to go out and fetch the bison's head. So we dispersed. I took some sardines, bread, and a water bottle. No fresh tracks of buffalo were found till we got into the main river 3 miles from camp. There to our joy we found solitary tracks. Optimistically feeling sure it was my big bull off we went first through light hilly jungles and then into heavy grass. I suddenly got a sight of his body in a hollow, but he disappeared before I could see his horns. Then he got wind of us and increased his pace, and I only got one more glimpse of him in a 3 hour track. This glimpse was of the tips of his horns, and showed he was obviously not the one we thought we were after, so we gave up the chase at about 10.30 all of us fairly weary already.

We worked our way back to the river, and while the men revelled in the beautiful clear water that here was running freely I had my fish breakfast. Then we all lay down in the thickest shade we could find and discussed our further actions. We decided to rest till 3 p.m. and then to work up the other tributary of the big river looking for other solitary tracks and hoping to come across our buffalo on the way home in the afternoon. It meant a long way to camp, but the memory of that mighty head made it seem worth while. So we spent the afternoon sleeping and exchanging yarns. Karriya told me he had come across a tiger treed by wild dogs. The dogs had killed a sambhar and evidently the tiger had tried to butt in, for when Karriya arrived on the scene the dogs were eating the kill and the tiger was clinging to the sloping trunk of a tree ten feet from the ground. He was sure the sambhar had been killed by the dogs, and not by the tiger. When he appeared the tiger sprang to the ground and dashed off, and the dogs dispersed in all directions, while Karriya annexed the kill which was quite fresh, a good effort for a man armed only with the light axe every Gond carries in the jungle. Mahadeo shikari had got into trouble last year for shooting a tiger outside the area permitted on his gun license, and I asked him how it had happened. He said he was going along and suddenly saw some wild dogs round a kill. When he appeared the dogs retreated and he found the remains of a sambhar fawn. He went scouting round to get a shot at the dogs with his ancient muzzle loader, and about 400 yards from the kill he saw some yellow animal in the grass about 15 yards away. To his horror he saw it was striped, and as it had not seen him he fired and dropped it dead with one shot in the shoulder. Another stout effort. On going up he found it was a tigress which had been killing a sambhar hind. This is an extraordinary case of traditional enemies hunting together. The cream of the story is that the hind suddenly to Mahadeo's disgust got up and ran away, the explanation being evident from an examination of the tigress which was so old that her teeth were all blunted and innocuous. She had managed to pull the hind down but could not kill it. These men also told me they had heard tigers imitate a sambhar's call and their theory was that this call was an invitation from a tiger to his mate to come and share a kill.

With these and other yarns from the wise men of the forests the time passed pleasantly enough till it was time to move. We proceeded up the new river bed and the trek was brightened by the sudden appearance of a fine sambhar stag near the edge of the jungle, which I dropped with a shot from the ·577. Unfortunately it dashed wildly over some rocks and crashed, breaking off both its horns, which were just on the point of being shed naturally We eventually found buffalo tracks, but it was then late and we were seven miles from camp and dog tired, so I decided to make for home. We were all very glad to see the first flicker of camp fires through the trees.

Next morning I bade a regretful farewell to my Gond friends and rode away from Baisagaon taking with me happy memories of my few strenuous and interesting days in these beautiful jungles.

Some day perhaps I may return to find that buffalo with his horns bigger and his temper shorter, and then, well here's hoping !

J. A. DUKE,
Indian Police.

RAIPUR, C. P.

II.—MONKEYS AND CARNIVORA

A point which I would like to mention in connection with 'R.B.'s' review of my book in Vol. XXXII No. 4 is in regard to the accuracy of the information of the presence of Carnivora as indicated by the alarm cries of langoors. I have given this point my very careful attention for a long time and particularly after discussing the matter with Colonel Burton. Personally, I have never yet been let down by a langoor, whereas, as far as these particular forests are concerned, *Macacus rhesus*, although a useful indicator, is often quite unreliable. 'R.B.' mentions that he has had langoors give the alarm call for a yellow dog, whereas the *Macacus* monkeys were silent : I would reply by saying that I have a black Labrador bitch, who habitually accompanies me in the jungle, and wherever I go the *Macacus* monkeys call at her, whereas the langoors usually ignore her altogether ! Evidently conditions vary tremendously from place to place and this example only emphasizes how very unwise it is to make a definite statement about the habits of any particular species of animal. Truly Emerson knew what he was saying when he wrote :

'Nature will not be Buddist ; she resents generalizing and insults the philosopher in every moment with a million of fresh particulars.'

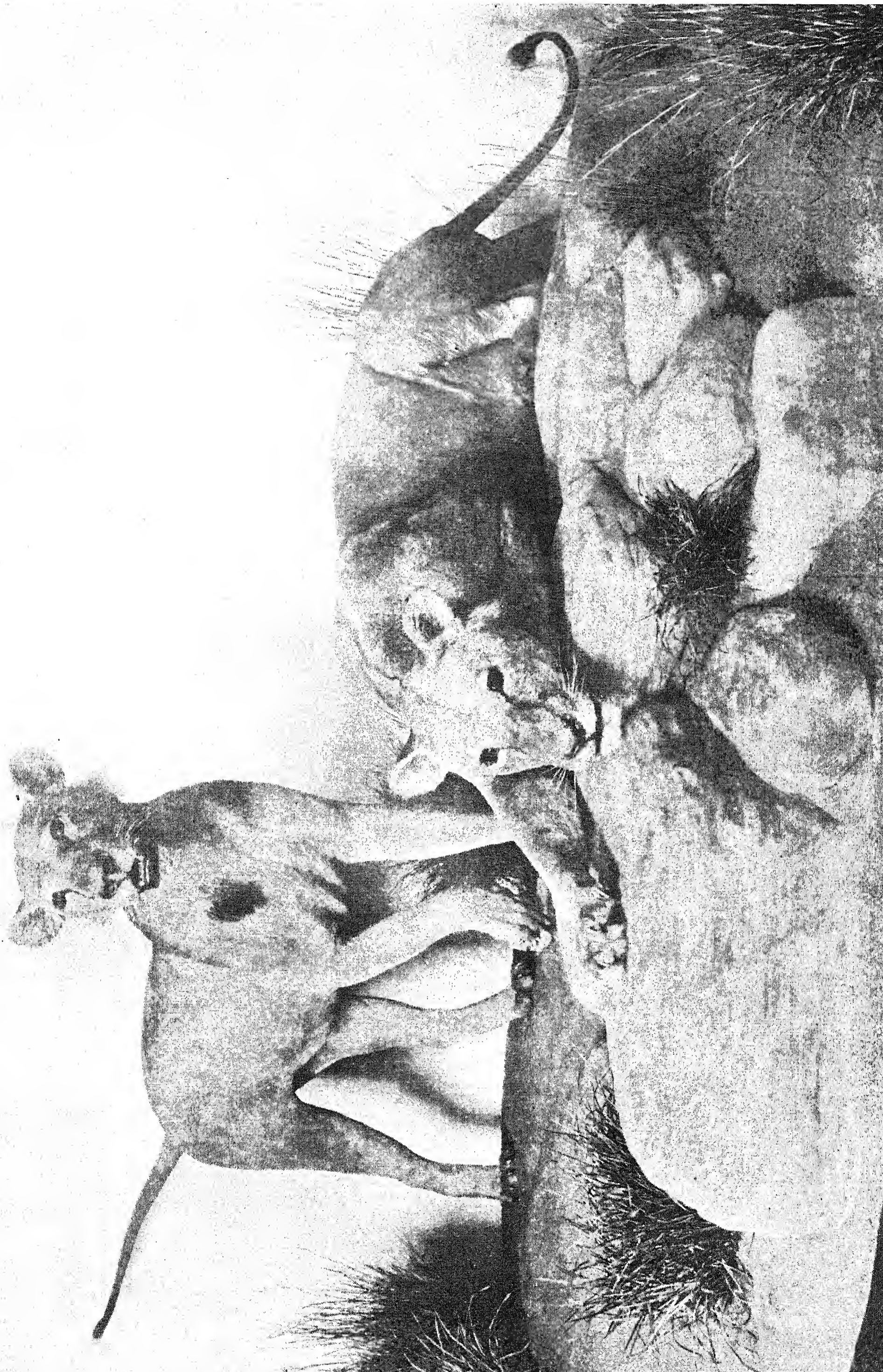
F. W. CHAMPION,
Indian Forest Service.

LANSDOWNE,
August 3, 1928.

III.—'THE MAN-EATERS OF TSAVO

(With a plate)

Those who have read *The Man-eaters of Tsavo* will be interested in the accompanying photograph of the two lions which formed the subject of Col. Patterson's classic work. The original specimens were purchased by Mr. Stanley Field and presented by him to the Field Museum, Chicago, where they have been mounted and placed on exhibition. The ferocity, the boldness and infinite cunning of these lions was almost beyond belief. Their victims included several white men, 28 coolies and more than 100 Indian and African labourers. Their ravages put a temporary stoppage to



the construction of the Uganda Railway and the story of their depredations is perhaps the most extraordinary one of man-eating beasts on record.

Although both were males it will be seen that they carried practically no manes. Among African lions, between the animal with hardly a vestige of a mane and the much less common though far handsomer beast with a flowing black mane, every possible intermediate variety may be found. Selous has shown that full-maned lions and others with scarcely any mane at all may be found occupying the same territory. The maneless condition of the lions of the Gir Forest of Kathiawar, the last stronghold of the lion in India, is well known. Yet lions from Africa and India grow luxuriant manes in captivity. Selous was unable to account for the variation in the length and colour of the mane in different individual lions. He did not consider the theory tenable that the maneless condition of many lions in the wild state was due to the density and thorny nature of the jungles in which they lived. He shows that on the high open plateaus of Matabele and in the Mashuna country, where scarcely a thorn bush is to be seen, lions of every variety as regards length and condition of mane are to be found. The same variation also occurs in the neighbourhood of Tati where the country is for the most part covered with thick thorn jungle.

Our thanks are due to the Field Museum, Chicago for permission to publish this interesting photograph.

BOMBAY NATURAL HISTORY SOCIETY,

October 12, 1928. EDITORS.

IV.—WOUNDED TIGER RETURNING TO KILLS

It is an interesting fact that in recent years two cases have occurred in this District of wounded tiger returning to their kills on the following night, or rather in one instance the tiger killed again on the following night. In the first case a planter on these hills wounded a tiger at night and on approaching the kill early the following morning observed the tiger standing alongside the kill. The tiger saw him and dashed off and fresh blood was found all round the kill where the tiger had been feeding. The tiger did not appear again and could not be located. In the second instance a visitor to these hills wounded a tiger at night when sitting up over its kill. On the following morning every foot of the jungle was searched for some distance round with the aid of a herd of buffaloes. There was very little blood and the tracks of the tiger were lost not far from the kill. On the following night another kill occurred and was obviously the work of the same tiger as blood was found in three or four of its forms where it lay up in the jungle near the kill after feeding. The tiger returned to its kill again the next night, but as the kill had been dragged from the very thick stuff it had been in for a yard or two into more open ground, the tiger evidently

got suspicious and went off without actually coming up to its kill. In both the above cases the tiger must have only received a slight wound.

HONNAMETTI ESTATE,
ATTIKAN P.O.,
Via MYSORE,
June 7, 1928.

RALPH C. MORRIS.

V.—MEASUREMENTS OF PANTHERS

Major Logan Home in his letter dated August 1927, asks for particulars of any large leopards. I enclose the details of a particularly large panther, shot by me in Nimar in April 1923. It was a large massive animal and I at first thought it must be a tiger as it had killed a large cow from the local herd. I was alone at the time so have no witness to corroborate the measurements.

Measurements taken with a steel tape

Length between pegs	7′ 8″
Tail	2′ 11″
Girth	2′ 9″
Forearm	11″
Neck	1′ 8″

The present length of the skin (which was salted and not pegged out) is 8′ 4″.

QUETTA,
June 1928.

J. R. STOCKLEY ROPER,
Lieut., R.A.

VI.—BREEDING HABITS OF THE COMMON MONGOOSE (*HERPESTES EDWARDSI*)

The following notes on the breeding of the common Indian Mongoose may be of interest.

In mid-1926 my daughter obtained a pair of young animals who must have been born about May 1926. The male was given to biting the servants' bare feet and died young, death being attributed to a party of chokras in the neighbourhood. The female, of an unusually timid and retiring disposition, continued to inhabit the bungalow but would not let any one but my daughter, who fed her, handle her.

In February 1927 she took to wandering out into the highways and hedges for about a week or ten days, and early in May she gave birth to a pair of young in the roof of the bungalow. I should

say that she can climb almost as well as a cat and has been seen to jump a vertical height upwards of 4′ 2″ with a ten-day old baby in her mouth. The animal herself is some 18″–20″ long, small of her kind. This family gives us a probable period of gestation of at least sixty days.

Some ten days to a fortnight after the appearance of her nipples and sundry squeaks and scufflings in the roof had roused suspicion, she brought one down when she came for her food, a male which spat and tried to bite when picked up, but soon became amenable.

The mother to my surprise made no objection to her baby being handled by myself or my servants (my family had fled from the approaching South-west monsoon) but after a time having fed she came, calling, and the baby, whom we will call the 'First male', was released and after a thorough exploration of the bungalow, was taken back up into the roof.

The following day a female was brought down and much the same performance gone through. She was a good bit smaller than her brother and as she only lived about three weeks, dying of some stomach trouble, we need not bother to name her. The mother made a fuss calling if they were detained so they were let run loose and soon took to evading any attempts to handle them.

First male continued to run with his mother and to come to food until in September 1927, when he was about half grown, a second pair of babies were produced in the roof. Much the same performance about bringing them down, and I was surprised to see that the mother made no objection to First male joining the family party. Again the female died young leaving the mother with two sons First male and Second male.

In the end of October and early November the mother and First male were seen pairing on three or four different occasions, and at Christmas a third pair of babies was born out in the compound. We have never handled these but from later observation I am able to say that they were male and female, Third male and third female, period of gestation about sixty days again.

On April 1 and 4, 1928, I saw the mother pairing with First male, easily distinguished by his size from Second male. The act was repeated half a dozen or more times, in my view, at intervals of a few minutes on each occasion.

Now comes a puzzle as on April 28, she was seen, again by me, apparently pairing with Second male. Same repeated performance with no attempt at evasion on the part of the female, yet she must have been impregnated on April 1/4, as the fourth pair were produced on June 5, sixty-one days from April 4, and only thirty-eight from April 28. What is one to believe?

Now, in September 1928, the mother, third female and fourth pair, who are again male and female, come in to feed. First male has not been seen for some time though his presence in the roof has been suspected. Second male and Third male gave up coming to food about the middle of August though they probably inspect the bungalow when it is quiet in the afternoon, when they used to

come into my daughter's room for a game that didn't run to handling, just the usual look through my hind legs, jumps and combined family ball wrestle quite a tangle with about four in the ball. They are very intrigued by anything, an egg for preference, in a basin of water. The babies we were able to handle swam well and strong from the beginning though they did not appear to like it.

When the babies were very small the mother used to hide one and be seen convoying the other, the hidden one remaining silent and still until mother returned for it. Later both would run with her. They run close into her side stopping when she does and are very inconspicuous. The mother was seen to attack, furiously, a prowling cat four to six times her size. The cat didn't wait, and I've never seen one travel faster. No notice is taken of a terrier in the house; no familiarity, just friendly neutrality on both sides. They are regularly fed and I daresay there's lots of small game about, but, in a good hour be it said, they have not so far interfered with the chicken run which is easy of access.

Scorpions and such like small game are not uncommon in these parts but none have been seen in my bungalow these past two years.

It has been an interesting performance to watch, as I did not know that they bred more than once in a year though where I got that idea I cannot tell you.

CANNANORE, A. G. FRERE, I.A., F.Z.S.,
September 11, 1928. *Lieutenant-Colonel.*

[Writing to us further on the subject on November 14, Colonel Frere states as follows:—'The mother produced a fifth family on the night of October 28/29, 1928. No pairing had been seen. Her figure was commented upon a week previously and on 29th was seen to be reduced and nipples prominent. Beyond that, only scamperings in the roof, as she had not brought them down when I proceeded to camp on the 10th.'

These notes are of great interest as so little is known of the breeding habits of this exceedingly common animal. Blandford commenting on the breeding of the mongoose says that 'young are seen in the Spring' but it is obvious from Colonel Frere's experience that they may be seen at any time of the year. EDS.]

VII.—A STALWART PARIAH DOG

During my tour in April I got *khabber* one day of a tiger kill 5 miles away, a cow being the victim. On going to sit up I found it was obviously a leopard kill. It was so close to the village that I felt sure the leopard would come late if at all, so I went back to camp. Next morning news was brought that a mile from the previous kill one of my tied-up bullocks had been killed by the same leopard. I sat up till 1 a.m., but the leopard did not come though I heard him 'sawing' in the distance. Next morning there was no kill, but as I had nothing else to do, and this leopard appeared to be an exceptionally big one, and an absolute scourge to the villages,

having killed two ponies as well as many cattle, I determined to sit up over a pi-dog. On arrival at the village I found the only dog they had succeeded in catching was a half-grown pup, which wagged its tail at me in such a friendly way that I could not bear to have it tied up. So I demanded a goat instead. I went out and chose a tree about 400 yards from the village and 200 from a big hill from which I thought the leopard was most likely to come. I had a machan put up about 8 feet from the ground in a thick fig tree, and the goat was tied up about 20 yards away. The shikaries went off, and the goat took up a statuesque attitude beside the peg to which it was tied, and remained absolutely silent. I sat this out for 10 minutes and then blew my whistle. When the men turned up I ordered a change of goat. They had another ready and the change was quickly made. The new recruit was as useless as the other. He started trying to commit suicide by hanging, but never opened his mouth. Again I whistled and this time sent for a pi-dog. After some delay they caught a full grown medium-sized dog and chained him up to the peg. He also was a non-co-operator, so again I whistled for help. By this time I was getting a bit fed up and pessimistic, as it was quite dark and the men came along with lanterns. However I said another dog must be produced. The shikaries were also a bit fed up at the unaccommodating attitude of the local domestic animals, and before going off one of them gave the pi-dog a couple of whacks with a cane. The dog was naturally furious and expressed his feelings in fierce growls and, thank goodness, two or three loud barks. The men and their lantern had just got out of sight and silence reigned, and I had put my rifle down on the machan and my back against a branch, thinking of the 4 miles back to dinner and was it worth it, etc., etc. I had an electric torch fastened on to my rifle. Suddenly the silence was rent by a series of howls, growls and barks from the dog. I leapt to attention, seized my rifle, put it up, and turned on the light. There was the dog dancing round his peg, demonstrating furiously against something which was outside the circle of vision revealed to me through the hole I had made through the leaves. I switched off my torch. In a few seconds the uproar again increased, and again I switched on the light, to find only the agitated dog visible. I switched off again. In a few seconds the noise redoubled in intensity and when I switched on this time I saw a very large leopard attacking the unfortunate dog. The leopard was moving round in a circle and hitting out at the dog with his claws, but was obviously deterred from going right in and killing with his teeth by the dog's gallant and terrific defence. Neither took any notice of my light, which was almost horizontal, my machan being so low, and I got my sights on to the leopard and put a bullet into his spine as quickly as I could He went off a short distance and was picked up next day. After the shot the dog continued to bark vociferously in the directions in which the stricken leopard had gone, bravado I suppose. Just as I was getting down he managed to detach the chain, and bolted off into the jungle, naturally in the opposite direction to that of the leopard. I am glad to record he rolled up in his village alright

and complete with chain. He had lost a good deal of skin from his face and chest, but so far as I know is alive and well to this day. Is there an expression ' The face of a lion and the heart of a pi '? If so, for ' pi ' read ' leopard ' in future.

J. A. DUKE,
Indian Police.

VIII.—SOME OBSERVATIONS ON WILD ELEPHANTS IN ORISSA

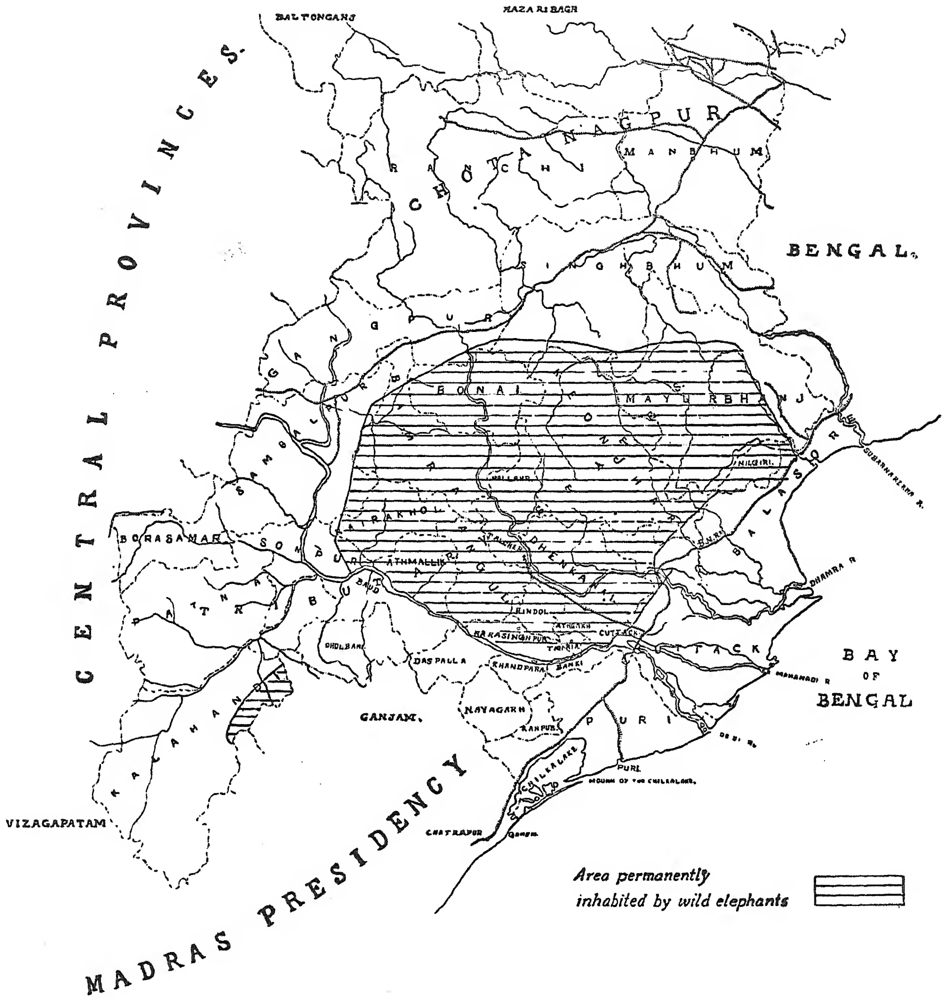
(With a map)

Wild elephants in the province of Bihar and Orissa are entirely confined to the Native States, Angul district and a small area in the west of Singhbhum district. Outside this tract they are nowhere else resident in the province, but do occasionally wander into the adjoining districts of British India at certain times of the year.

The Feudatory States of Orissa (with Angul district) are about thirty thousand square miles in extent; they are very sparsely populated and largely covered in forest. Some of these jungles are very extensive, especially those lying between the Mahanadi river and the main line of the Bengal-Nagpur Railway, and contain vast quantities of bamboos. These forests provide an ideal sanctuary for elephants as both water and fodder are plentiful, while their inaccessibility and dense cover afford an excellent retreat in the hot weather. It is interesting to note that, with the exception of one large herd in the extreme south-west of the area on the borders of Vizagapatam district, elephants are not found permanently south of the Mahanadi, although they occasionally cross it in the rainy season. The jungles south of the river are similar in all respects to those lying north of it and abound in bamboos, but the water supply of the southern States is scanty and this would account for their absence from this tract. An abundant supply of water is essential. Mayurbhanj State with its vast extent of forest-clad hills and perennial streams is the largest sanctuary in Orissa.

It would be extremely difficult to estimate accurately the number of wild elephants in the Feudatory States, but there are not less than five hundred, and may be considerably more. The herds seem to contain nine to twelve individuals as a rule; but occasionally they are met with in considerably larger numbers, probably due to the temporary fusion of two or more herds. Single animals are frequently met with and appear to be invariably bulls. These males do not, I believe, lead an entirely solitary existence but associate with the herd when so inclined. It is my experience that they are for the most part the biggest tuskers, so that their absence from the herd is more likely of their own choosing, and not because they have been driven from it. A few old males may through failing strength be deprived of the leadership of the herd and compelled to lead a solitary life, for a time at least. I have frequently watched

MAP OF ORISSA



herds feeding and have noticed that they usually consist of young bulls, cows and calves ; the big tuskers being generally found feeding at some distance from the main herd. It appears to be not unusual to find two such bulls in company.

From February to the break of the monsoon the elephants are located in the heavier jungles where feeding is good and water abundant, but during the rains they move widely throughout the area and take a heavy toll of the crops in their wanderings. The damage done to paddy and sugarcane is considerable and in a few places this has become a serious menace, land going out of cultivation since the raiyats seldom succeed in reaping a tithe of what they have sown. The problem of reducing the number of elephants is a difficult one ; for beyond the limited utility of *khedda* operations, no effective solution presents itself.

It is accepted as a fact by those with long local experience that elephants have been steadily on the increase in Orissa in recent times. This I believe to be unquestionable. The Elephant Preservation Act applies only in the British district of Angul, but elephants have always been protected in the States by the Rajas. Both Angul and the Feudatory States have been the scene of *khedda* operations for many years past and from time to time considerable catches are made. Beyond this casualties are very few indeed. The number of elephants trapped during the past ten or fifteen years would not exceed an average of twenty annually. The calves born each year must be in excess of this figure so that *kheddas*, on their present scale, do not succeed in coping with the natural increase. Last cold weather exceptionally large catches were made, aggregating sixty-nine animals in all.

Mr. Champion, in vol. xxxii, No. 1 of the Journal, attributes the slow rate of increase among the wild elephants of the United Provinces to in-breeding. The fact that in Orissa the numbers are considerable and the herds are spread over a larger area might account for their being more prolific. Certainly any of the herds I have seen have contained a good number of calves, and they also invariably constitute a large proportion of the number trapped.

Casualties from disease and bullet are not great ; perhaps four or five animals each year.

Much mystery has become attached to the death of elephants. They are reputed to seek out some remote and secluded spot, to which they retreat when they feel their powers failing and death approaching. This legend is very widespread but has not yet been substantiated. It is a picturesque story, which seems in keeping with such a unique animal as the elephant. The actual facts appear to me to be very ordinary. When one takes into consideration the long life span of an elephant, deaths amongst them must be comparatively infrequent. One would not therefore expect to find many corpses even where elephants were numerous. Furthermore, the rapidity with which decomposition sets in and removes all traces of the animal must be seen to be believed. Two rainy seasons are sufficient for the complete destruction of everything except the largest bones.

In the area with which I am dealing, annually a few elephants are found dead and some tusks are brought in for the reward. Even though much of the tract is sparsely populated, I am of opinion that most elephants that die are found by the villagers living on the outskirits of the forests and are thus accounted for. Such deaths probably do not exceed three or four annually in the whole area, if as many. In addition, a few rogues are occasionally shot. Thus the total decrease from death and capture would not exceed twenty to twenty-five yearly.

Of the deaths recorded a large number seem to be the result of wounds inflicted in fights between tuskers. Two instances of this have come to my notice in the last four years in which both animals succumbed, and two other cases of tuskers being gored to death were reported. As to the cause of death in other cases, I am unable to give any details, but mortality from old age must be extremely rare.

A very curious incident took place in Keonjhar State in November last, which is worth recording.

A villager was sitting in a *machan* watching his crops, when an elephant entered his field and commenced helping itself to his paddy. In the hopes of driving the animal away, the man fired an arrow at the elephant which was fifty feet from him. The elephant, which turned out to be a very ancient and decrepit cow, left the field and was found dead two hundred yards away next morning with the arrow in its forehead. The villager was arrested for killing the elephant and there was much discussion as to whether the arrow was poisoned or not. The man himself said that it was not, and this is probably the truth as the aboriginals of these parts do not normally use poisoned arrows. It *may* have been poisoned but I think not. It is unfortunate that the skull was not examined to ascertain how far the arrow had penetrated. It must, one presumes, have reached the brain to have caused death, but it is difficult to believe that an arrow shot from an ordinary bow could do so in spite of the fact that it would only have to pass through soft tissues, and little or no bone. Again, even had the arrow been poisoned, death seems to have followed very rapidly on the infliction of the wound. Whatever the exact cause of death, the fact remains that the elephant was struck by the arrow and was found dead close by next morning.

The facts of this remarkable incident were related to me by the magistrate before whom the case was brought, and by the forest officer of the State, within a month of the occurrence and their accuracy can be vouched for.

The bulls seem to carry, on the whole, very fair sized ivory in Orissa. The largest pair of tusks I have seen are a pair in the possession of the Maharaja of Mayurbhanj, which measure 8′ 6″ along the outer curve. They are a symmetrical pair of great beauty and are said to have been taken from a tame elephant, which died in captivity. One which I shot in 1925 had tusks measuring 6′ 10″ and 6′ 6″, which weighed 62 and 59 lbs. respectively. These were not at all symmetrical and one was considerably broken at the

point. This elephant taped 9′ 1″ at the shoulder, as accurately as I could measure, the girth of his feet being 55″ and 54½ inches Another rogue shot in Angul district in 1923 had a single tusk which weighed 62½ lbs. This was a very massive tusk and had a girth at the thickest part of almost 20 inches. A large bull, which was found dead in the same district in March this year, had tusks measuring 6′ 1″ each and weighing 140 lbs. the pair. This elephant had a deep wound in his flank, probably inflicted in a fight with another tusker.

I have seen a number of tusks weighing between forty and fifty pounds, and I should say as a result of my observations that many elephants have tusks of forty pounds apiece and not a few carry ivory much in excess of this figure.

As far as I am aware, the elephants in Orissa are isolated and are not connected with herds in any other part of India unless perhaps in the extreme south-west of the area, where it borders on the Vizagapatam district of Madras. I believe that a few solitary elephants occur in Ganjam district, but whether or not there is any connecting link between those of Orissa and Southern India I do not know and should be interested to learn.

SAMBALPUR, B. N. RY.,
ORISSA,
July 24, 1928.

H. F. MOONEY,
I.F.S.

IX.—ON 'NATURAL DEATHS' IN WILD ELEPHANTS

I was very interested in Mr. Morris' comments on my article 'Wild Elephants in the United Provinces', which were published in volume xxxii, No. 4, page 794 of the Journal. I am glad to hear of other cases of wild elephants attempting to move the carcases of their dead companions and it would be of absorbing interest to learn why they attempt to do this. A 'jungle funeral' by elephants would certainly form a very fine theme for those who write fantastic stories on life in the jungle!

In my own mind I have little doubt that the case I previously recorded was a genuine one of death from over age; but Mr. Morris' suggestion of poisoning by villagers is a very sound one, which had not occurred to me before and which might certainly account for the deaths of some wild elephants. In this connection we have recently had another death in the jungles in my charge and it is possible that this case might be attributed to this cause. The elephant in question was a medium-sized tusker, with tusks 48 inches and 44 inches long and of a total weight of 65 lbs. The tusks were in moderately good condition and did not appear to be very old. The animal was found dead on the side of a small stony stream on June 1, 1928 and had presumably died the night before. I was unfortunately unable to visit the spot, but I give below some notes on the case based partly on my own knowledge and partly on a report from a local Range Officer.

History. This tusker had been living alone in the Rawasan

forests for some years. He was quiet in temperament and did not attempt to interfere with the local jungle workmen.

Appearance. The carcase was found lying on its side on the edge of water. The body looked fairly healthy and was not emaciated. The skin was considerably wrinkled, and there were deep depressions above the eyes. The ears had lost their shape after death, but they were not ragged. Unfortunately no observations were made as to the amount of turn-over of the upper rims of the ears.

Teeth. There was one small very worn molar at the back of each side of the lower jaw. The upper jaw was damaged in removing the tusks, so that an examination of the upper molars could not be made. The tusks were 48 ″ and 44 ″ long respectively and together weighed 65 lbs. They were in moderately good condition.

Droppings. Old and fresh droppings and the contents of the open stomach were examined. In all three cases the bark of Pula (*Kydia calycina*) had been eaten and was not properly masticated or digested, long fibres being present.

Cause of death. No wound of any sort was visible on the upper side of the carcase, which was too heavy to lift for an examination of the lower side. As far a layman could tell, a contributary cause of death was impaired digestion owing to failing teeth ; but, although the animal was considerably past his prime, he did not appear to have been sufficiently old to have died from this cause. There is extensive cultivation on the edge of the jungle less than a mile away from where the elephant was found dead and I know that he and other local wild elephants occasionally raided the villagers' crops, paticularly during the monsoon. The villagers indignantly deny having put out poison for the wild elephants, as they must do if they wish to avoid prosecution : but there is a distinct suspicion that this may have been done, and I much regret now that I did not have samples of the blood and stomach contents taken for microscopic examination.

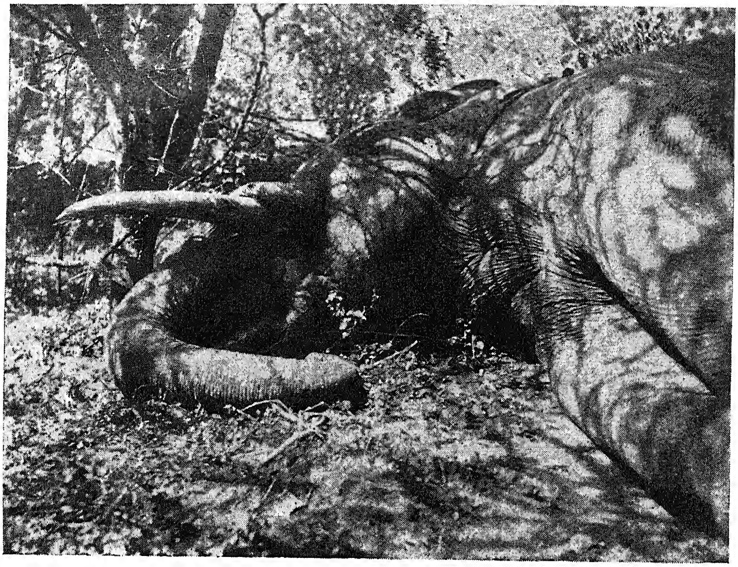
In any case, whatever the cause of death may have been, it is to be noted that the carcase was found in a very open river-bed, on the edge of water, and within half-a-mile of human habitation. It may be that, if the animal had been poisoned, death came so suddenly that it did not have the chance to seek seclusion in the dense neighbouring forests, which it should have done if we are to accept the usual theory on the subject.

LANSDOWNE, F. W. CHAMPION,
November 2, 1928. *Indian Forest Service.*

X.—A LARGE TUSKER FROM SOUTH INDIA

(*With a plate*)

Having read various notes regarding the height attained by Indian Elephants in your Journal, I am sending you the measurements of a tusker I was lucky enough to bag on the Gandamanayakanoor Zamindaries in the Madura District on 15th April last.



A Good Tusker shot by Mr. D. R. D. Wadia in the Madura District (South India).

The same animal, showing position in which measurements were taken.

You will notice that I have taken two measurements of the animal —one at the highest point and one at the shoulder.

I was unable to make the fore legs of the animal absolutely straight after it had fallen on its side, and I mention this point to make it clear, that, if, anything, the measurements are rather on the pessimistic than on the optimistic side.

Perhaps a few details of the shoot may be of interest to your readers, so I give a short account below :—

The Gandamanayakanoor Zamindaries cover an area of 240 sq. miles out of which only 100 are cultivated (tea, cotton, wheat, cardamons, etc.) The headquarters are at Gandamanayakanoor, 65 miles from Madura which, incidentally, is your last rail-head. I left the H.Q. on April 1st for my first camp at Myladampadi which is 12 miles away. This place was selected because there is a tin shed there, and as it was continually raining in the evenings, the prospect of spending nights under damp canvas did not quite appeal to me! As things turned out, it was just as well that I did not push on into the interior. After 14 days of depressing inactivity, owing to incessant rain I had nearly made up my mind to chuck it, and pack up for home. However signs of favourable weather made me decide to chance it and push on another 20 miles to Udangal, where according to local gossip dwelt 'Record' Bison, Tiger, and a host of other game! Consequently I got all the necessary things ready, and we left on the 15th, at 7 a.m. on foot. We had hardly gone for half an hour when we happened on a lot of elephant tracks which could not have been very old. There were over 20 distinct sets of foot prints of fairly large animals as well as some of baby elephants. After searching about for the definite tracks of a tusker, and not being satisfied, I decided to push on at a rapid pace to the next village (Kumlundhulu) 7½ miles further, so as to circumvent the herd if possible. However, we were spared the trouble as 100 yds. further fresh spoor of elephant[1] were picked up and this time we could hardly restrain our excitement as among them were a set of huge footprints which my men swore were those of a 'mighty tusker'; this was soon confirmed by the damage to the tree trunks, and a little further on the impression of a tusk in the soft mud-bank of a dry nullah. Here was undoubtedly the best piece of luck we had struck so far, and we decided to track the animal forthwith. Tracking through the soft sand was easy enough, but five minutes of it brought us into very thick jungle. We were stalking along a regular elephant run; the visibility ahead was fairly good, but hardly encouraging. Another 15 minutes and we heard the elephant *behind* us not more than 150 yds. away; we hastily tested the wind and finding it against us ran back 50 yds. or so and waited. There was another path at right angles to the track we were following and the shikaris expected them to break cover about 30 yds. in front, when I could have a good shot as they crossed the opening. All the time we could hear the herd feeding and approaching well spread out, but we could not get a glimpse of the animals. It was hardly a comfortable situation, specially when I realized that they were rather a large herd and that there

was no means of avoiding a stampede, should it take place in our direction. We had no choice, however, so we decided on the 'wait and see' policy, frequently testing the wind which was most fickle. We had not long to wait before a fairly large female leisurely strolled past the expected spot; she had a calf at heel. Then followed another female who half glanced towards where we crouched, then another calf. This little chap took quite a good look in our direction, but fortunately his interest was not intelligent! The fifth to cross was the 'Lord and Master' of the herd, with a natty line in 'ivory tuskings', so I let him have the right in the temple—a ·470 solid. He fell on his knees, but recovered himself and just as he was trying to stand up, I gave him the left, which I found later hit him 2″ below the first shot. This crumpled him up completely, and after turning in our direction he collapsed. All this time, which could not have been more than a few seconds, we had hardly paid any attention to his companions who were feeding around. These got alarmed on hearing the sudden reports, and a general stampede commenced. One of my men shinned up a neighbouring tree, the other whisked forward and crouched near the dead elephant, while I made for a small opening where the bushes were not so thick. I had just enough time to turn back and see five or seven elephants rushing past in Indian file within 2 yds. of the spot whence I had fired, and immediately under my second shikari. I pushed through the thorny undergrowth to what I imagined was safety; when, looking down, fresh footprints and droppings all over the place reminded me that it was not so very safe after all. I had no idea whether the whole herd had passed or whether there were more coming over, but needless to say, I beat it quick.

Fortunately the storm had blown over, everybody was safe, and the tusker was bagged. I shall never forget the moment when I came up to see the stout lad! As he lay there, he presented a magnificent spectacle and seemed immense. My men were highly excited and started tugging at his tail and slapping him in delight.

The measuring was done in under 30 minutes of the animal's being shot, and were later checked by the Manager of the Estate and another gentleman.

I sent the measurements to Rowland Wards and they are published in the new edition of their Records. I am told that the correct method of measuring an elephant is to take the height at the highest point, i.e. to the slight ridge they have on their spine—please correct me if I am wrong, and Rowland Ward's best is 10′ 6″.

Any members wishing to go on a trip to these jungles should write to Messrs. Patel Bros., 6, Napier Road, Fort, Bombay for full particulars, and if there is anything they would like me to tell them, I shall be very glad to give every help.

The measurements of my tusker were as follows :—

Height at shoulder (between pegs)	10′ 2″
,, ,, highest point ,, ...	10′ 9″

Total length from tip of trunk to tip of tail (over curves)	22′ 6″
Circumference of left-forefoot	5′ 0″
Tusk (r)	5′ 4″
,, (l)	5′ 4″

D. R. D. WADIA.

7, Marine Lines,
Fort,
Bombay,
July 27, 1928.

[The correct method of measuring the height of an elephant according to Lieut.-Col. G. H. Evans ('Elephants and their Diseases') is at the shoulder, as is done in horses. The height at the highest point of the back, however, would always form an interesting and useful additional record. Eds.]

XI.—HEIGHT IN ELEPHANTS

With reference to the note No. XVII in vol. xxxii, No. 3 'A Large Tusker Elephant', I would point out that during several years' experience of measuring elephants in jungle camps in Burma I invariably found that twice round the forefoot gave the height at the shoulder within (at the most) one inch of accuracy. This would tend to confirm Mr. John's estimate of 10′ 9″ (twice 65″) in regard to the tusker discussed despite anything that Mr. Sanderson (great authority that he was) may have written. I fancy others engaged in timber work or forest service will back me up in this; above all it would be interesting to learn what Col. G. H. Evans thinks, since in Burma, before the war we regarded him as *the* authority on elephants.

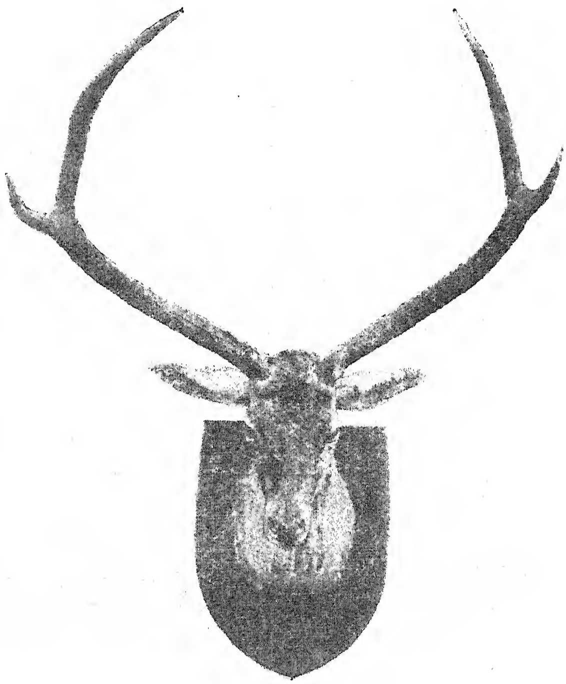
At Sea, DAVID BOYLE.
May 25, 1928.

[In 'Elephants and their Diseases' Col. G. H. Evans writes, 'We may take it on the authority of Sanderson, a most careful observer, that such a thing as an elephant measuring 10 ft. at the shoulder does not exist in India, nor may I add in Burma.' The largest male met by Sanderson measured 9 ft. 10 ins. The biggest male owned by the Bombay Burma Trading Co. measured 9 ft. 6½ ins. and the company have records of more than a thousand animals. Twice round the circumference of the forefoot is as nearly as possible the height at the shoulder. This rule, however, according to Evans, does not always hold good in the case of young growing animals. In the case of a young elephant owned by Mr. P. B. Kelly of the Forest Department twice the circumference of his forefoot exceeded the height by 9 ins. Eds].

XII.—ABNORMAL ANTLERS OF A KASHMIR STAG (*CERVUS HANGLU*)

(*With a photo*)

I enclose a photograph of the head of a barasingh shot by me. It appears exceptional in view of the fact that it has only 6 points.



The following are the measurements.

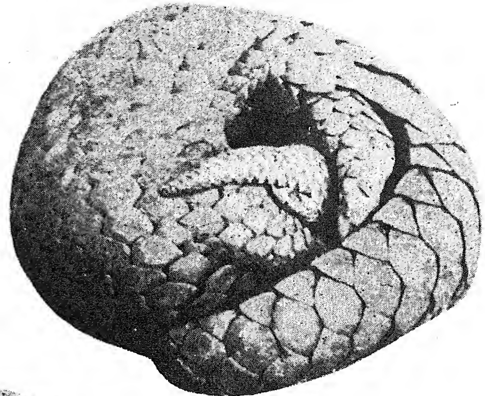
Shot in Basmai Nullah, Sind Valley, Kashmir, September 16th.

Right horn	...	43″
Left horn	...	39″
Widest, tip to tip	...	$42\frac{1}{2}$″
Circumference at base	...	$7\frac{1}{2}$″
,, in middle	...	$8\frac{1}{4}$″

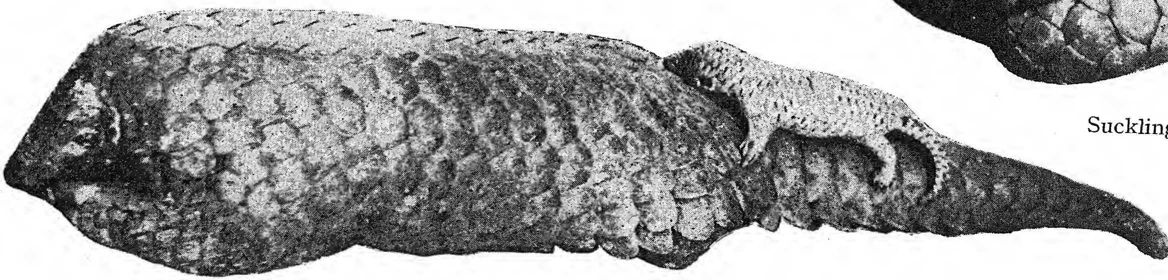
MURREE,
June 4, 1928.

G. M. GAMBLE,
Capt.
The Sherwood Foresters.

Female and young.



Suckling.



Resting.

Photographs by *Gordon Hundley.*

THE CHINESE PANGOLIN.
(*Manis pentadactyla.*)

XIII.—CLICKING NOISE MADE BY MUNTJAC

It is, I think, necessary—in view of the note on this subject at page 795, vol. xxxii, No. 4, by Mr. B. B. Osmaston—to elucidate further my meaning. Possibly I did not express myself sufficiently clearly when writing on former occasions, and I am now without any of the previous notes or copies of them to refer to.

My contention is that the very slight clicking noise which is to be heard when the Muntjac is close to one moving slowly and quietly in puzzled alarm cannot be heard when the animal bounds off. When the animal, fully alarmed, bounds away, a much louder clicking is heard. I have of course heard it many, many times during the past thirty-eight years in India and in all parts of the country including the United Provinces and the Central Provinces. A voice call it is without doubt. Possibly it is merely a louder development of the low and quiet clickings which I have heard, as I have tried to explain, *before* the animal has made any audible movement at all.

I have a recollection of having read somewhere lately—perhaps it was in a recent issue of this Journal ?—that a Muntjac in captivity has been observed making this clicking noise to which I refer by a movement of its tongue. That, if a fact, should put an end to any doubt in the matter.

R. W. BURTON,
Lieut.-Colonel,
Indian Army (Retired).

[The reference in the last para of the above note is to the remarks made on the subject by Mr. Theobald on page, 593 of vol. xxxii. EDS.]

XIV.—SOME NOTES ON THE PANGOLIN (*MANIS PENTADACTYLA*) IN BURMA.

(*With a plate*)

Recently Mr. Gordon Hundley of Messrs. Steel Brothers and Company, Limited, captured in the Pyinmana district, Upper Burma, two adult females and one baby Pangolin (*Manis pentadactyla*) and sent them to the Rangoon Zoological Gardens. As the Rangoon Zoo has received several of these animals in recent years and as they have all died owing to their being impossible to feed, it was decided to release them and they were let loose in the jungle near Rangoon—the mother carrying away the baby riding on her tail as is shown in the accompanying photograph.

Pangolins are common throughout Burma and it is believed that their food consists chiefly of white ants. They spend the day as a rule in deep holes but they are good climbers and I have found them in the daytime in the branches of a tree. They are of interest owing to the fact that though possessing scales they are mammals and suckle their young. Unlike most small mammals, they have only a single pair of mammary glands on the chest. They share with the binturong (*Arctictis binturong*), also found in Burma, the

distinction of being the only two mammals of the Old World possessing prehensile tails. (Nearly all mammals having prehensile tails are natives of South America).

The Burmans call them *thingwegyat* and believe that they have the power of making a sound resembling a human voice and in this way they call people. If a man is called by a pangolin and replies, it is believed that he will die immediately. The death of a Forest Ranger at the Pyinmana Forest School some years ago was ascribed to his having replied to a *thingwegyat*. It would be interesting to know the origin of this superstition, which is widespread throughout Burma and also among the Laos and Karens, especially as it is most probable that these animals are incapable of making any noise at all. The Burman is, owing to this belief, always reluctant to answer the shouts of any travellers who have lost their way and who may be making for camp at night.

I enclose three photos which were taken by Mr. G. Hundley showing the infant riding on his mother's back and also the infant suckling.

S. F. HOPWOOD,
I.F.S.

July 25, 1928.

[Three species of Pangolins or Scaly Ant-eaters are included in the Indian fauna. The Indian Scaly Ant-eater (*Manis crassicaudata*), the Chinese species (*M. pentadactyla—M. aurita* of Blanford) which ranges through Nepal, Sikhim, Assam and Burma and the Malayan species, *M. javanica* which occurs in Tenasserim. Our Scaly Ant-eaters are generally, though erroneously, referred to as Armadillos. Armadillos are members of a distinct family, the *Dasypodidæ*, confined to the American Continent. They have all a more or less rigid covering of bony plates imbedded in the skin which are not in the least comparable to the scales of our Pangolins. The Scaly Ant-eaters are characterised by their want of teeth; while the term 'Edentate' (without teeth) is scarcely applicable to the Armadillos all of which possess teeth. Between the scales of a Pangolin lie hairs which seem to be absent in the adults of African species, though present in the young. This serves as a distinguishing feature between Oriental and Ethiopian forms. The scales may be looked upon as hairs, or rather spines, enormously enlarged and dilated.

In vol. xi, p. 165 of the *Journal*, Mr. A. L. Butler records the digging out of a family of Scaly Ant-eaters. The burrow was about 8 feet in length and ended 4 feet underground in a circular chamber some 2 feet in diameter. The young one taken at the time was 18 inches long, much paler than the adults, and, says Mr. Butler, 'the female carried him everywhere on her back.' Mr. C. G. Chevenix Trench records his efforts to rear a baby Pangolin in vol. xxiv, p. 590 of the *Journal*. It was fed on cow's milk three times a day from an ordinary feeding bottle with a rubber nipple and drank about one-third of a pint daily, diluted to the proportions of two parts of milk to one part of water. The note records that the animal was quite healthy but very sensitive to cold and died on its transfer to a colder district early in December. Between August and December on the above regimen it had nearly doubled its weight.

In his notes on the habitat of the Chinese Pangolin, published in vol. xix, p. 254, Capt. F. E. Venning mentions a curious superstition prevalent among the Chins. According to them it is an exceedingly evil omen to meet a Pangolin (*sapu*) by day. Writing of a specimen brought to him by some Chins, he states that as a climber it was most agile and when once on a bough was very difficult to detach. It would roll itself into a ball round a bough and even when its tail was detached by main force it still clung on tightly with its fore claws hooked over the bough and its stumpy hind feet pressed against it. Mr. Trench's specimen was also an active climber and if left on the ground would make for a chair leg or a human being and climb up like a bear.

We reproduce the following note by Mr. W. W. A. Phillips, F.Z.S., on the habits of the closely related Indian species (*M. crassicaudata*) which appeared recently in *Spolia Zeylonica* :—

'I have recently received letters from Dr. Pearson, Director of the Colombo Museum, and Dr. Lucian de Zilwa of Colombo, which are of much interest as they throw new light upon the habits of that little known animal, the Pangolin.

It is well-known that the Indian or Ceylon Pangolin is normally purely nocturnal in its movements, spending the day curled up asleep at the bottom of its burrow. It is therefore interesting to learn something of the habits of this curious animal when in captivity, almost the only condition under which it may be studied.

Not long ago a female and her baby (the Pangolin usually produces only one at a time) were brought to the Museum and lived there long enough to enable Dr. Pearson to make some interesting observations upon their habits.

He writes to me as follows :—"The mother has a very curious way of carrying her baby. . . . The baby scrambles on to the mother's tail and hangs on tight, lying across the tail as a rule; then the mother starts off in a very clumsy manner, first lifting her tail clear off the ground. When the mother is alarmed she flexes her tail and neck under the ventral part of her body and the baby finds shelter in the cavity thus formed."

It would seem probable that this is the usual method adopted by the Pangolin when transferring its young from place to place; and that, should an alarm occur, the mother protects her otherwise defenceless young in the manner described in the latter part of Dr. Pearson's letter.

Unhappily, although the mother lived for some considerable time the young one did not survive long enough to permit a satisfactory photograph being secured of it in this position. Dr. Pearson also informs me that the adult Pangolin is able to climb the trunks of trees with the aid of an oblique grip of its tail.

The second letter, from Dr. Lucian de Zilwa, is chiefly concerned with the feeding of the Pangolin in captivity. He writes as follows :—"I have trained my Pangolin to drink unboiled milk. I had to dip his nose in it at first, but he now laps it up with great avidity and makes a dash for the enamelled plate as soon as he is let out of the wooden cage in which he lives. He drinks about half a

bottle of milk daily and also gets some leaf-nests of ants when we can procure them. Besides this he is given custard or milk pudding such as sago, tapioca, etc. He grubs about apparently finding a lot to eat under flower pots and barrels and will burrow into an ant-hill and apparently find food. White-ants (termites) found under a stone or a log he will not look at, and he will not eat the ferocious little red ants commonly found in the garden, but he will lick up the inoffensive black ant. He relishes ant's eggs more than ants themselves and particularly loves those big leaf-nests of the red ant, with millions of ants and eggs. The large red ants out of these leaf-nests bite his stomach and get on to his face, so that he has to pause occasionally to scratch his abdomen or remove them from his face."

Dr. de Zilwa goes on to say "sometimes he appears very excitable and rolls himself in a puddle of mud or wraps himself round a stone or fallen coconut. I have wondered whether he might be suffering from sexual excitement at such times. . . . He enjoys a swim in a big bath-tub and often wallows in mud." Dr. de Zilwa has had his Pangolin for over 18 months and it has now grown considerably. It is interesting to note that it does not appear to relish white-ants (termites) which are believed to be its usual food and also that it prefers the leaf-nests of the large red-ant to any other food. It is possibly these leaf-nests which induce the animal to climb."

In his field notes relating to a female *M. pentadactyla* collected by Mr. J. P. Mills, I.C.S., for the Society's Mammal Survey in the Naga Hills (E. Burma), he remarks: 'Can burrow with amazing speed. Chang Nagas will only eat one if they can kill it before it has curled up sufficiently for its tongue to reach its genital organs. Otherwise the meat will be bitter.' EDS.]

XV.—THE BABBLER AS A BAROMETER

The following little incident with regard to the Common Babbler (*Argya caudata caudata*) might be of some interest to our members and I send it for what it is worth.

I was spending July in a Canal Bungalow in the Gujranwala District, and just in front of the verandah is a small Tun tree, not more than 20 feet in height. Every evening a flock of babblers arrived and settled down for the night on one of the lowest branches. I could easily have reached them from the ground with my raised hand.

It was most amusing to see them select their perch. Three or four would first of all make themselves comfortable and others would line up on either side, but invaribly one or two appeared to be left out. They would not settle down at the end of the line but must needs try to get in the middle, by hopping about on the backs of those already there, which would resist the attempts. It usually ended in the interloper selecting a stray branch for himself and once there he, or she, hopped round and round as though extremely pleased with the choice and chirruping to the others. Sooner or

later one or two would leave their original perch and go and join it, thus upsetting the whole party, as one by one they would all follow. Then one would come back to the original spot and would be followed by the others. This happened every evening and at least three attempts were made to select the right spot, which invariably ended in their going back to exactly the same one each night, and every night two, or three would be left out of the party to sit by themselves elsewhere. There were nine in all.

They did not mind me at all and, once comfortably settled, would allow me to come immediately under them, and not 2 feet distant.

I noticed that normally they sat anyhow, i.e., two facing one way and the next in the opposite direction, and so on throughout the line.

On the 11th evening I noticed them all facing in the same direction, facing east. That evening there was a fairly heavy storm from the south-west but the prevailing wind was due east.

On the 14th there was another storm about midnight, and before I went to bed I had a look at my friends and found them all facing east again.

On the 24th there was not a cloud in the sky, and it was dead still, when the babblers went to roost, but I noticed they had all faced the east from the start, and there was not a single tail in that direction. I remarked to my servants that there was going to be a storm during the night and told them how I knew! Sure enough there was a colossal one with a wind that uprooted a good many trees in the vicinity. How the babblers weathered it I do not know, for their little tree, to say nothing of the tiny branch they sat on, must have been beaten down almost to the ground many times. However, next evening they were there again, all nine of them, and thereafter one or the other of my servants always come to see how the birds were sitting!

When sitting so close together it is obvious they cannot turn round to face any storm, but what happens should the wind change direction?

DHARMSALA Cantonment C. H. DONALD.
August 5, 1928.

[Mr. Donald's notes on the babbler recall Mr. Meyer's observations on the peacock as a weather prophet. In his recently published book *Birds and Beasts of a Roman Zoo* (reviewed on p. 394 of this journal) which contains much interesting information on the behaviour of animals in captivity, Mr. Meyer recognizes three distinct calls in the peacock. Firstly, the well-known unmusical call, secondly a quavering note of alarm which his birds invariably used when they were disturbed by a tame cheetah which had a free run of the gardens and lastly a peculiar creaking cry, not so loud as the ordinary call, which always accurately foretold rain or thunder. As a weather prophet, Meyer considers the peacock superior to the tree-frog. Its peculiar cry is never deceptive, rain or thunder always follows shortly. Have any of our readers made a similar observation on the peacock in the wild state? EDS.]

XVI.—THE NESTING HABITS OF THE NORTHERN GREY HORNBILL (*LOPHOCEROS BIROSTRIS*)

I discovered a nest of the above in a large hole in a mango tree at the south end of a fair sized mango grove, enclosed by a high wall. This nest was difficult to discover, as the male bird was very wary and would not approach anywhere near when I was about. The hole too, was on the upperside of a stunted bough, and could not be seen from the ground as it was some 25 or 30 feet high. It was an ideal place for a nest of the kind. On May 23 I had a long ladder brought and mounting this I discovered that my suspicions were correct as the entrance to the large hole was packed with ordure on both sides, as is the custom with this bird—the slit in the centre was about ½″ wide and about 4″ long. I opened up the entrance, and putting in my arm to beyond my elbow discovered two eggs which were lying on decayed pieces of bark, etc. With the exception of a few feathers (evidently the bird's own) there was no attempt at making a nest. The bird disappeared up the large cavity inside the tree, and I could not reach her at all. The eggs when blown were quite fresh. I came away leaving the hole open and the bird inside, thinking she would now forsake the nest, but, on visiting the place again on June 2, I discovered that the hole had been closed in again as formerly. I had it opened up again thinking, she might have laid a second time, but on this occasion there were no eggs. On June 6 and 16 I paid it other visits thinking the bird must surely have forsaken the hole after so many upsets of the domestic arrangements, but no, she had packed herself in again as before. I opened the nest twice again thinking, that she must have laid by now, or, perhaps that she had laid farther up the cavity somewhere; I had the hole opened up again and then the old bough sawn off to enable me to make a thorough search, which I did, but no eggs were forthcoming, nor was there any ledge farther up the tree where she could have deposited the eggs. I got the female out of the nest, and discovered later that there was no sign of her laying at all in the near future. It surprised me to discover how quickly she could plaster up the hole again which was large enough to let my arm and hand in easily as such a lot of ordure was required for the purpose, and what her object was in staying in the hole so long when her nest had been so frequently disturbed would be interesting to find out, particularly as she hadn't laid a second time, nor were there any signs of her doing so. Perhaps this account of the only Hornbill we seem to have in the Punjab may prove of interest to some of the members of the Bombay Natural History Society, and if any of them can throw any further light on this interesting bird's habits and intentions, one would be glad to hear of similar experiences of others for reference and comparison.

The bird is rather rare here and the nest hard to find. I have been fortunate in discovering two nests with fresh eggs in them this season but the nests were eighteen miles apart. You'll notice

that I opened this one up no less than four times, and I suppose the bird would have carried on still further if I hadn't cut the nest about so badly.

She was in fairly good condition, and only moulting of the primaries had taken place and new quills had been formed, and these were about half-developed I should say. The old feathers were all in the nest. In both instances when I took the eggs from the nest of a Hornbill, the male bird didn't put in an appearance at all nor did the female put up any kind of a fight with the exception of pecking at one's finger once or twice. She did not screech at all either. If I get a chance again I will make closer observations next time.

J. D. FINLAY.

BATALA,
GURDASPUR DIST.,
PUNJAB.
June 20, 1928.

[General Osborne, in a note published in vol. xiv, p. 715 of the Journal, indicated that the peculiar nesting habits of the Hornbills was due to the fact that the sitting hen moulted all the quill feathers of her wings and tail during the period of her incarceration. Thus in the security of her walled-in nest she was protected and concealed at a time when she would have been otherwise at a great disadvantage. In his examination of the nest of a Great Indian Hornbill, in a tree in the Kanara forest, containing a young one, Mr. Tugersee discovered a quantity of tail and wing quills at the bottom of the hollow, which were shed by the sitting bird. Her condition when she arrived in Bombay a few days after capture showed that flight would have been a practical impossibility till the primary feathers of her wings, which were just sprouting, had matured. The rebuilding of the protecting wall after the eggs had been removed, as observed by Mr. Finlay is an interesting point. A possible explanation is that the incubating instinct being still active, the bird continued to sit in spite of the fact that her eggs were removed. There are several instances on record of birds brooding in empty nests. Again it may be suggested that the bird's reluctance to leave the nest was an instinctive disinclination to abandon the seclusion of her retreat until her powers of flight were fully restored. EDS.]

XVII.—OCCURRENCE OF THE XMAS ISLAND FRIGATE-BIRD (*FREGATA ANDREWSI*) ON THE WEST COAST OF INDIA

Among the contributions to the Museum recently received by the Society is the skin of an Xmas Island Frigate Bird or Man-of-War Bird (*Fregata andrewsi*) from Quilon, Travancore. The specimen was presented by Mr. L. A. Lampard. It was caught in a fishing net in a rough sea at the onset of the monsoon. 'When being examined,'

writes Mr. Lampard, 'it ejected a small fish which apparently came out of its gullet.'

This frigate bird is described as a rare visitor to the coasts of India. It is found throughout the tropical seas and oceans and is pre-eminently oceanic in habit, seldom coming to land except near its breeding quarters. At rare intervals they may be found sitting asleep upon the shore. Surface-swimming fish are said to be their main food. Squids, small crabs, flying-fish and young turtles are also eaten. Their habit of pursuing Terns, Boobies and the like and forcing their terrified victims to disgorge their prey which is nimbly caught up, before it drops into the water is recorded by Forbes in his 'Naturalist's Wanderings.' If secured in an akward position the captures are tossed in the air caught up again and swallowed. The young are fed by regurgitation. Both parents incubate and are very close sitters merely snapping at an intruder and showing the greatest reluctance to leave the nest.

S. H. PRATER.
C.M.Z.S.

BOMBAY NATURAL HISTORY
SOCIETY,
July 1928.

XVIII.– OCCURRENCE OF THE SHELDRAKE *TADORNA TADORNA* IN THE UNITED PROVINCES

I see some letters about the 'Common' Sheldrake in your Journal. I found a pair once in the year 1894 in Banda District, U.P. and shot one. I have never seen it in the U.P. since then. These birds were on a small tank quite close to a village. The one I shot proved to be quite uneatable.

J. C. FAUNTHORPE,
I.C.S., C.B.E., M.C., V.D.

XIX.—MIGRATION OF WILDFOWL

(*With a map*)

Since we published the last record of the recovery of ducks ringed in Dhar State in the Journal (vol. xxxii. p. 222) the following interesting note referring to the subject has appeared in the German publication *Ornithologische Monatsberichte* (vol. xxxvi, No. 3, May 1928) by H. von Grote of which a free translation is given below. The question whether our wildfowl always return to India after breeding or whether some of them intermittently wander off to Denmark and the neighbouring countries and *vice versa*, is one of the many problems whose solution we look for to our Ringing Scheme. This manifestly is the only means by which definite knowledge of the movements of individual birds can be btained,

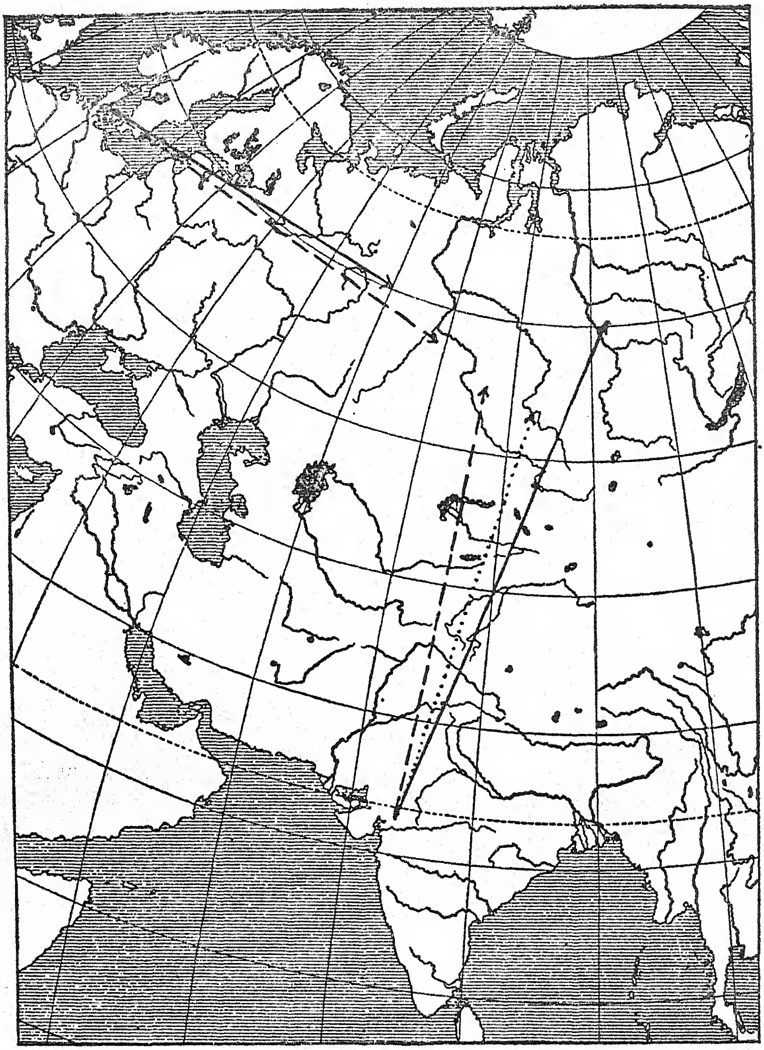
provided of course that members will give it the support it deserves.

'We are indebted to Siberian ornithologists for their work in throwing light on the routes taken by migrating ducks which breed in Sibera. It is well known that some time ago von Mortensen succeeded in tracing down marked Pintails (*Anas acuta acuta*) to their breeding grounds about 200 kilometers east of Perm (near the western frontier of Siberia). Later, during the war, A. Tjulpanow recorded in Poljakow's *Ornith Mitt.* (p. 252, 1915) the recovery of a Wigeon (*Anas penelope*) on May 6, 1915 below the town of Tobolsk, on the river Wogulka, which carried a ring with the inscription 'H. Chr. C. Mortensen, Viborg—Denmark 78 2 X'. The former bird as well as this Wigeon had their breeding haunts in West Siberia and had sought winter quarters in a directly western direction towards Denmark. To these very important records we have now to add three recent and remarkable instances of middle Siberian ducks journeying for the winter in a directly southern direction towards India. This was discovered by means of the ducks which H.H. The Maharaja Saheb of Dhar had captured and ringed in his state in large numbers during the winter months. The first of these records is made by H. Johansen in the journal for Siberian ornithology 'Uragus' (1927, No. 1, pp. 30-31) to the effect that on May 30, 1926, there was caught in a fishing net near the village of Ssusslowo near Barnaul) a Pochard (*Nyroca ferina ferina*) which had a metal ring on its leg with the inscription 'Inform Maharaja Dhar 58'. Enquiries showed that this duck was marked in Dhar in February of the same year. The ring had consequently been on the bird for a hundred days before it was recaptured in its Siberian breeding grounds.

The second report is in connection with a Wigeon (*Anas penelope*) and is published in the same journal by J. M. Salesski. This Wigeon accompanied by young ones was taken on August 1, 1926 on the Ilbosch Lake in the neighbourhood of Kargat station of the Omsk Railway. The ring which she carried had the same inscription only with the number 38. This specimen had also been ringed in Dhar in February 1926.

The third report is made by W. Troizky, Curator of the Zoological Department, Novo Sibirsko Museum in the 'Uragus' No. 4, 1927, p. 26, who states that on August 6, 1927, an aluminium ring was received by him from a man named Kacherowsky, a State commercial officer, which bore the inscription 'Inform Maharaja Dhar'. The ring was rather mutilated, so that the last two letters of the word Maharaja were lost as was also the number. This metal ring had been obtained on May 29 from a female Pintail (*Anas acuta acuta*) captured by a native on the river Tira, the left branch of the river Tiga, which in its turn flows into the Chatanga (middle Tunguska).

We see therefore that two ducks, a Pintail and a Wigeon, journeyed from their West Siberian home to winter in Denmark, while three others, a Pintail, a Pochard and a Wigeon migrated to India for their winter quarters. However, on the strength of these



MIGRATORY DIRECTIONS TAKEN BY MARKED DUCKS
——PINTAIL (*Anas acuta*),.........WIGEON (*Anas penelope*), ...
POCHARD (*Nyroca ferina*)

few records it would be too premature to form the conclusion that it is the custom with all West Siberian ducks to migrate in one direction while all middle Siberian ducks take another, especially as it is known that the Anatidæ are somewhat erratic as to the directions they select for flight. The precise routes followed by Siberian ducks to India is a matter for conjecture. It is possible that they take a westerly direction to circumvent the Highlands of Central

Asia. But in this connection it must also be remembered that Sven Hedin has seen large numbers of migrating ducks at great heights in Tibet, as for example at the source of the Indus, in autumn.

It is to be hoped that the zeal of the Russian ornithologists will soon bring to light fu ther material in connection with the routes taken by Siberian ducks.'

6, Apollo Street, EDITORS.
November 8, 1928.

XX.—THE FLIGHT OF BIRDS AT HIGH ALTITUDES

It seems to me a remarkable fact that birds can fly with such apparent ease through very attenuated air. We are so accustomed to regard birds as highly modified for their particular medium. Their bones are hollow, and they are provided with air-sacs, it is said, in order to fit them for flight. Consequently we may feel a little surprise when we find how independent they are of the supporting power of the air.

When we ascend to 15,000 feet we find the pressure of the atmosphere almost halved : it possesses only half its supporting power. It might be anticipated that birds would suffer as a result of so great a change. But the facts are completely different. Birds at this height, and at much greater altitudes, fly with apparently the same facility as they do at sea level. To all appearances they are unaffected by the change.

Those of ordinary capacities of flight, such as mountain finches and Tibetan larks, fly about with their accustomed ease. Hill-pigeons fly as swiftly round the cliffs, choughs come as freely to the travellers' camps as do their representatives at the level of the sea. Even birds with highly specialized forms of flight seem equally unaffected by the lighter air. The snowcock is a bird that glides or parachutes, rarely if ever beating its wings. Yet it lives exclusively in this rarified atmosphere where it floats majestically across a gorge. The kestrel and some terns are poising birds, holding themselves stationary at one spot by forcibly beating their wings. Such poising is a highly specialized evolution. No form of ærial activity calls for so much exertion on the part of the bird. One might think that a mode of flight demanding so much effort would be impossible in rarified air. Yet in Tibet we see terns hovering over lakes, their bodies on a slant, their wings forcibly beating as they hold themselves stationary at fixed points. They poise as efficiently at 15,000 feet as they do along the sea shore. It is the same with the kestrel at high altitudes. I have seen it poised at 16,000 feet, and, when the wind was strong, it held itself stationary with scarcely a quiver of the wing. Indeed, so far from the thin air preventing its evolutions, the kestrel in Tibet has to hover perpetually. For on the plateau there are no trees or points of vantage from where it can keep a look-out for prey. Certain other birds surprise us by this remarkable independence. The ground-chough, for instance, has unusually weak flight, seldom going more

than a hundred yards at a time, and looking something like a fledgling that has just escaped from the nest. Yet it is a bird that lives exclusively at high altitudes. We meet with it in Tibet at 13,000 feet where it seems quite at home in the rarified air. The flight of the skylark is out of the ordinary. It towers up perpendicularly through the air while pouring forth its melodious notes. Yet its towerings seem in no way affected by altitude. In Tibet it towers and sings at 15,000 feet as delightfully as in an English field.

It is the same with soaring birds. Eagles and buzzards at 16,000 feet sail and circle with the same ease as do their representatives at moderate heights. The griffon loves to sail over Himalayan passes. I have often watched its effortless motion at a height of 20,000 feet. The lammergeyer used to visit our Mount Everest base camp and at that height of 17,000 feet used to float and circle and glide downward after food with all its accustomed facility and grace. Nor can it just sail in circles at this considerable height, but can carry itself up through the attenuated air without making the slightest movement of its wings. I do not know to what a height it can perform this feat. Certainly it can sail across the main Himalaya at the great height of 23,000 feet.

Birds which visited the Mount Everest base camps seemed in no way incommoded by the thin atmosphere. We had choughs and pigeons in Camp I at 18,000 feet, crows and mountain-finches in Camp III at 21,000 feet, choughs almost daily in Camp IV at 23,000 feet. Indeed choughs seemed completely independent of altitude for they followed the climbers to the immense height of 27,000 feet. Their capacities of flight appeared in no way diminished. There was nothing to show that they moved through an atmosphere reduced to one-third of its supporting power.

Thus we see how independent birds seem to be of the supporting influence of the air. Diminish the pressure of the atmosphere by half and ordinary flight seems in no way affected. And even those more elaborate ærial performances, such as parachuting, hovering, towering, soaring, are all performed with perfect ease.

R. W. G. HINGSTON,
Major, I.M.S.

XXI.—THE OCCURRENCE OF THE GHARIAL (*GAVIALIS GANGETICUS*) IN BURMA

Mr. H. B. Prior has very kindly forwarded to me the skull of a crocodile recently shot in the Shweli River in Upper Burma.

We have sent you the skull because it is believed to be a gharial and the first record of its occurrence in Burma.

Moreover the fact of its being killed in the Shweli, well over a thousand miles by river from the delta of the Irrawaddi, is a point of great interest.

The crocodile was shot by Mr. Hannyngton at the mouth of the Maingtha Stream some 40 miles from the mouth of the Shweli, which runs into the Irrawaddi about 20 miles below Katha.

It was shot in July of this year (1927) and the measurements were as follows :—

Over-all length	...	16′ 6″
Mid girth (at thickest point)	...	6′ 6″
Breast girth	...	5′ 7″
Tail length	...	7′ 9″
Body (neck to base of tail)	...	6′ 3″

Mr. J. A. E. Upton has kindly supplied the following details :—

'I saw it the day after it was shot. It is undoubtedly a gharial or fish-eater, the technical name being I believe *Gavialis gangeticus*, colour, webbed feet, crested legs and long snout all agreeing with W. S. Burke's description in the *Indian Field Shikar Book*. When skinned, one spherical ball was found in the stomach.'

'A crocodile' has been reported by villagers at the mouth of the Maingtha for some years past. It is usually seen after the first rise in the Shweli, about the end of June, and never after the river has sunk to its cold weather level in December.'

Since this one was shot another is rumoured to have appeared on one or two occasions near Molon (near mouth of Maingtha), but so far I have had no opportunity of verifying this. A crocodile was shot in the Shweli some years ago but unfortunately was not identified.

These crocodiles appear to go to the main Irrawaddi after the rains as I have rumours of them having been seen near Tagaung in the hot weather.

I should be very grateful if you would let me have a note as to its identification after you have examined it.

MAYMYO, BURMA,
December 24, 1927. C. G. BARTON.

[The skull forwarded to us is, as identified, that of a Gharial or Gavial (*Gavialis gangeticus*) and its occurrence in the area mentioned, marks a considerable extension of its known habitat. This species has hitherto been known to occur in the Indus, Ganges and Brahmaputra rivers and their larger tributaries, also in the Mahanadi of Orissa and the Koladyne (Koladainge) or Kaladan River of Arrakan—the latter being the only known record of its occurrence in Burma. Its discovery in the Maingtha Stream a sub-tributary of the Irrawaddy therefore is of considerable interest.

The Irrawaddy is formed by the confluence of the Mali-Kha and N'mai-Kha rivers both of which appear to have their sources in the region of the Nam-Kui Mts. on the southern borders of Tibet on whose western slopes some of the tributaries of the Brahmaputra have their origin. The small streams and water courses of this region *may* have provided the means of intercommunication between the tributaries of the Brahmaputra and the Irrawaddy and have accounted for the extension of the range of this crocodile. EDS.]

XXII.—ON SOME COMMON INDIAN LIZARDS

Readers of Pierre Loti's diary during his two years sojourn in French Guinea (Senegal) will remember that this emotional impressionistic writer refers to the glowing cœrulean-hued lizards with orange coloured heads that sometimes strayed into the wooden bungalow which he occupied. Loti was not drawing on his imagination, nor was he seeing objects through a haze of the 'blues', as large massive-headed lizards of the agamoid family, the males glowing with the tints of a turquoise or sapphire, can also be seen in East Africa where the gaudy coloured males are known to residents of the colony as 'cocks' and the females as 'hens'. In India on barren rocks at the Himalayan hill-stations of Simla, Mussoorie and Naini Tal the large ugly blackish-brown *Agama tuberculata* is commonly met with, the male of which develops a blue patch on the throat during the hot months. It is not quite certain whether the *Agama* found at the foot of the hills near Dehra Dun belongs to this species. They are thirsty creatures as during the hot months drowned specimens are sometimes to be seen in the waters of the fresh-water canal that flows along the side of a low spur of the Himalayas that overhangs the village of Rajpur about five miles to the east of Dehra Dun. This reptile like the first already alluded to, is perhaps equally ugly but has its redeeming points in the exhibition by the male of a series of spots of an intense peacock-blue during the hot months on the sides of the tail and flanks of the body. Boulenger in his hand-book on Indian Reptilia refers to *Agama dayana* as occurring at Hardwar about 40 miles further east but does not describe this lizard which must be identical with those seen near the village of Rajpur. *Charasia dorsalis* is very common on the volcanic groups of gneiss and trap rock that form so prominent a feature of the landscape in the vicinity of Bangalore. The usual colour of immature males and females is a greyish-white strongly assimilating in shade with the jagged surfaces of the rocks where they are found but the old males are highly conspicuous when perched on a pinnacle of rock, the upper parts of the body glowing in patches of lurid yellow and red in strong contrast to the jet black of the throat, the abdomen and the sides of the body. It certainly would not be difficult in the tumbled wastes of rock for a recluse to find a spot satisfying the requirements of the lines written by the great Roman satirist (Juvenal).

'Est aliquid, quocumque loco, quocumque recessu unius sese dominum fecisse lacertae'.

Charasia dorsalis does not seem to be distributed outside the Mysore plateau, as it was not observed amongst the boulders of the Mount of St. Thomas, nor on the high stony hill overlooking the little settlement of Pallaveram, nor on hills in its neighbourhood geologically interesting as the spot where Sir Thomas Holland procured specimens of 'Charnockite' gneiss and plutonic rock and which forms so considerable a part in the construction of the Madras Harbour Works.

The 'bloodsucker' is not a fearful form of Vampire but a harmless garden lizard about 16 inches in length with a spiny crest running down the back of the neck and the upper part of the dorsum. The scientific name *Calotes versicolar* as well as the popular one both refer to the occasions when the head, neck and upper portion of the body in this lizard acquire a dull sanguine hue whilst the remainder of the body may remain a pale greenish-yellow. Sometimes when running up or down a tree trunk a *Calotes* may assume a dark unpleasant tint mottled with patches of livid white, heightening its *tout ensemble* to the background of the tree-trunk scarred with the remains of the white and withered lichen of a past rainy season, or the body may be of a pale fleshy colour with lateral markings of pale yellow and a white throat but these are invariably females and young or immature males.

Punnett, in his "Mimicry amongst Butterflies" in a chapter devoted to the natural foes of those insects, suggests that the crimson colour assumed by the males of *Calotes* may serve as a lure to bring insects within striking distance of the lizard's mouth. An untenable suggestion, the colour being a secondary sexual characteristic like that of the vivid yellow assumed by males of the Indian bull-frog (*Rana tigrina*) at the onset of the rainy season. It has been ascertained by experiment that *Calotes* will devour at sight both palatable as well as distasteful butterflies. It has devoured indiscriminately *Catopsilia crocale*, *Papilio demolcus*, *P. polytes agamemnon* of the palatable group and equally impartially *Danais chrysippus*, *Euplœa core*, *Acræa violæ*, and *Papilio hector* of the distasteful, and Punnett from such data is doubtful whether the phenomenon of mimcry amongst butterflies has arisen from the action of lizards of the *Calotes* group. Such experiments under artificial conditions are really inconclusive as in a state of freedom *Calotes* does exhibit preference for certain butterflies that are found associated with particular trees or bushes. It has been observed on shrubs of *Triphasia trifoliata* and *Murraya exotica* on the look-out for stray specimens of *Papilio polytes* which frequently flit around the branchlets of such rutaceous plants. It may also be seen on branches of *Capparis zeylanica* which during the hot season are frequently visited by butterflies of the genus *Anaphæis* and other Pierines. On one occasion a large male *Calotes* was seen to seize and devour a Soap-nut Bug (*Tesseratoma javanica*), so common on the inferior surfaces of the leaves of *Sapindus trifoliatus*, the Soap-nut tree of Bombay and Western India. This large red shield-bug is very conspicuous on the wing from its slow laboured and beetle-like flight. Sometimes turning turtle when alighting on the ground and lying on its back it is a most conspicuous object from the contrast of the chalky whiteness of the abdomen against the colour of the earth ; feebly moving its legs it endeavours to right itself, an action which at once attracts the attention of any passing *Calotes*. The lizard is in its turn palatable and sometimes falls a prey to the Shikra Hawk (*Astur badius*) or to the Jungle Crow (*Corvus coronoides*). An azure-winged Indian roller (*Coracias indica*) has been seen to suddenly seize and carry off a small *Calotes*. 'A bolt from the blue indeed.' The long

limbs and toes of *Calotes* are perfectly adapted for a life amongst the trees and bushes on which it is found, but unlike the chamæleon it can run very quickly over the surface of the ground. It is a fact worth noting that the colour of the parasites which sometimes infest the body of a lizard can assume the colour of the scales of their host. Sir Joseph Hooker in his *Himalayan Journal* writes, 'Mr. Theobald pulled a lizard out from a hole. Its throat was mottled with scales of brown and yellow. Three ticks had fastened on it each of a size covering three or four scales. The first was yellow corresponding with the yellow colour of the animal's belly where it lodged. The second brown from the lizard's head but the third which was clinging to the particoloured scales of the neck had its body particoloured, the hues corresponding with the individual scales which they covered. The adoption of the two first specimens in colour to the parts to which they adhered is sufficiently remarkable but the third case was the most extraordinary.'

All observers must have frequently noticed a link of intimacy or friendship between animals that frequent the same spot although otherwise entirely dissimilar. One hot day at Madras the writer was watching a pair of 'blood-suckers' (*Calotes*) basking in the sun. Close by an attractive little grey squirrel was steadily munching at some choice nutty or fruity morsel held between his fore paws in typical sciurine fashion. Suddenly the smaller of the two lizards, the female, scurried up to the squirrel and tried to snatch his tit-bit away from him. He repelled her but not ungently with an air of disdainful but easy familiarity. Truly a pretty sight!

The little Indian wall-lizards or geckos that scamper across the walls and ceilings of rooms in keen pursuit of winged termites and fat-bodied moths are too well known to leave room for any further detailed observation. There is however an innate ferocity and pugnacity in these small geckos that is truly remarkable. A long sinuous rusty stain on the wall of a room recalls to the writer a conflict between two males of these Croquemouches, who clung to one another with the tenacity of bull-dogs, and the ferocity of their great ancestors, the monsters of the ancient slime. One of the combatants, after one of his fore-limbs had been crushed almost to a pulp in the jaws of his adversary, managed to break away and dragged his weary length along the surface of the wall until he finally disappeared behind the top of an adjoining cupboard. Who, unless he had witnessed such a conflict, could have guessed that the stain on the wall was that of a cold blooded reptile influenced by the same emotions that are only associated with the higher animals and the gods. 'Tantœnæ animis cœlestibus iræ.' Sometimes a small gecko may be seen resting on the side of a wall in the attitude of a cat asleep with its forefeet tucked under the body and the hind legs stretched out backwards. Or yet again he may be seen clinging to the outer surface of a window-pane but evincing no concern if the fingers of the hand are drummed against the inner surface of the pane. He is fully aware as long as he stays on the outer surface that he cannot be captured but will dart away like a flash even though the window be cautiously opened and the hand

carefully exserted to capture him. Like the famous Dr. Johnson he takes a practical view on the resistibility of matter and is aware that the hand cannot pass through window-panes without breakage. The great Burmese house-lizard or gecko (*Gecko verticillatus*), known as a 'Tuctoo' from its startling sonorous call is not uncommon in jungly suburban parts of Calcutta. They are considerably larger and decidedly uglier than the small geckos already considered, with fat bodies and large heads cryptically coloured in dark brown or grey shading to assimilate with the trunks of the trees to which they cling, the resemblance being further heightened by rusty or white mottling, over the body surface which gives the lizard an unpleasant appearance when closely viewed although it is perfectly harmless. Boulenger in his handbook on Indian Reptiles confines the limit of its extension into India to Eastern Bengal. In Calcutta it does not generally intrude into houses but confines itself to an arboreal life. One was heard however to utter its cry one evening from the wall of a house in Alipore Park, South, and another was said to have been seen and heard at the Golf Club at Tollygunge. The loud 'gee-ko', 'gee-ko' call from which it gets its onomatopœtic name may frequently be heard of an evening in the jungly bit of country adjoining the Jodhpur Club and its vicinity. There is a green gecko which inhabits the recesses of the torests of the Andamans and some parts of India. A true child of the wild it can only be sought for in the jungles where it is indigenous. Unlike the last it is a small gecko about the same size or a trifle smaller than the house-lizard first considered. Even to those who have never seen this beautiful little gecko, its verdant colour would indicate its arboreal habits and its close association with the leaves of trees.

THE STRANGERS HOME, H. JOUGUET.

MAZAGON, BOMBAY.

XXIII.—SOME NOTES ON THE TRAVANCORE EVENING BROWN BUTTERFLY (*PARANTIRRHŒA MARSHALLI*) IN COORG

Some time back Major H. C. Winckworth wrote to you announcing his capture of a *Parantirrhœa marshalli* ♂ near Watekolli in Coorg. Antram in his book *Butterflies of India* is of opinion that it appears in May and is probably single-brooded. By his capture of it in October (1926), Major Winckworth could claim that it is double-brooded. I obtained a male in May 1927: I believe Major Winckworth got several males in October of the same year. I missed one in that month and saw another in a neighbouring valley in Coorg. On January 28th last I caught what now I know to have been an old and damaged specimen of the female. I caught it at dusk above Watekolli on the Virajpet–Tellicherry ghaut road. In March, also at dusk, and again in April, I saw but failed to take this fly; whether male or female, I cannot say.

This month I determined to comb out the part of the jungle where I believed it to be. It has always been seen flying into or from a near 'Wate'—the giant bamboo reed (*Ochlandra Rheedie*)—which grows luxuriantly in this valley, as in other valleys. I had recently three days at my disposal and got fourteen specimens, of which four were females. Two of the females and two of the males were damaged in capture.

As the female is not described in the books, and, I believe, was sent to South Kensington only a very short time before Col. Evans' *Identification of Indian Butterflies* was published, I venture to send you the enclosed note on the insect. I am also sending you specimens of ♂ and ♀. I fear there may be technical errors in the description and hope you will set me right. My excuse is that I took up collecting only fourteen months ago, and am the perfect amateur.

I add a few notes on its habits as I have observed them in making my catches and my misses.

In the first place its flight is very slow and easy, as might be expected from its fragile wings. It protects itself by its shape and its colouring. Usually it is to be found sitting on the stem of the reed, or on a green leaf—often on the underside—, or on a dead leaf, or a loosened piece of dead fibre, such as surrounds the nodes With its curiously pointed wings folded, and its yellowish-brown (♂) or yellowish-grey (♀) underside, it is often very hard to distinguish from its perch. By tapping the stems of a clump of 'Wate' it can be disturbed, when it flies a yard or two on to another stem or leaf, more like a shadow or a falling leaf, such as frequently falls when the stems are tapped, and is, until the eye gets accustomed to its movements, almost immediately invisible. Sometimes it flies low and settles inside a clump of 'wate' stems at the base, when it is particularly hard to reach. This reed grows densely ; it is difficult to worm oneself in and out of it, and more difficult to wield a long stick (I generally use a 'wate' pole for its lightness), which is necessary because the butterfly often sits high up. I suppose the dark upperside, and even the white spots, are a natural aid to protection : the sunlight enters sparsely into these 'wate' groves, and only in patches; the stems are dark green, and the effect is a jazzed light. The butterfly-colour is protective jazz.

In gloomy damp weather the male will fly into the open, across a road or a glade—I say the male because the female, so far as Coorg goes, has never been caught in the open by day. It (the ♂) may be caught sitting on the underside or the upperside of a leaf on the shady side of a glade—generally in the morning until 11 or 12 o'clock. The female seems to come out at dusk, otherwise is to be got in the dark parts of a 'wate' grove. In flight, because of its greyer colour beneath and plain and lighter brown above, the female is less obvious than the male. I have noticed that in the day-time the fly seems to prefer those parts of a 'wate' grove which are denser and less penetrated by the sunlight. The same seems to be true of its co-habitants of the grove, *Zipœtis saitis* and *Discophora lepida ;*

In mentioning these two last, is it known on what they feed? I have caught many of the first and several of the second: all either in or near 'wate'. Had I time I should endeavour to find out if their food was the 'wate' leaf.

In your note to Major Winckworth's letter you remark that this fly is evidently spreading. It is, I suppose, 250 miles from Travancore to Coorg as the crow flies, and between the two are numerous valleys as rich probably in butterflies as this. I do not imagine that they have all been examined, or that *Parantirrhœa marshalli* has been searched for. The chances against getting it outside its jungle haunts are very small. Probably the butterfly is in those valleys as well, and the process of spreading has been of long duration. The flight of this fly does not suggest a leap of 250 miles in order to spread.

DESCRIPTION :

PARANTIRRHOEA MARSHALLI

Male

Below *unf* general effect pale yellowish-brown, obscurely striated darker brown. Three pale brown bars, basal, sub-basal and across cell from costa to v1 or v2. Cell band diverging and making a more or less obscure Y to costa. Broader discal band, slightly darker; also post-discal band of approximately the same colour. Space between discal and post-discal bands varied by series of minute black spots outwardly circled by opalescent or pearly white patches. Apex produced and pointed; termen nearly straight, rounded at tornus.

Unh subbasal and cell bars of *unf* obscurely continued. Two more or less dark spots in cell. Spot below cell. Spot near base. Discal and postdiscal bands of *unf* continued to v2. In interspace 2 (?) dark spot: between bands as on *unf* opalescent or pearly patches round darker minute spots.

H. W. half way along costa widely angled to apex. From apex to v4 (or 5 ?) termen straight (angle about 120) but slightly scalloped. At v5 (?) a tail inclined upwards. Tornus slightly outside a perpendicular drawn from apex. Dorsum nearly straight.

Above. General colour dark brown with purple tinge. *Upf* a somewhat kidney-shaped band of pale purple, starting just below costa beyond cell and continuing in patches between veins to near v1. Nearly parallel with termen, three white spots (appearing also *unf*) between vv3 and 7; the middle one of the series nearer to the upper one than the lower one. These traverse the purple band.

[I make no reference to the fold along the dorsum *f. w.*]

Female

1. Spread of wings $\frac{3}{16}''$ to $\frac{1}{4}''$ wider than in male. Height, when sitting with closed wings, from apex *hw* to dorsum *hw* $\frac{3}{32}''$ to $\frac{1}{8}''$ greater than that of male.

2. Dorsum *fw* nearly straight, only slightly bowed. Costa *hw* also nearly straight or only slightly bowed at centre.

3. *Beneath* more greyish-ochreous than yellowish-brown, with darker striation and bars. General markings much the same; but sub-basal band across cell *fw* and *hw*—especially *fw*—darker than in ♂ and discal band broad and inner edge sharper than in male. *Unh* spots cell and base obscure.

4. *Above* general colour dull bronze: series of five white spots parallel to termen. Nos. 2, 3, 4 most prominent, in decreasing magnitude. Nos. 1 and 5 varying from obscure to distinct, but not clear as Nos. 2, 3, 4. Nos. 2, 3, 4 appear beneath between discal and postdiscal bands, as in male.

5. Just below costa, above end cell a whitish spot, and between this and No. 3 of the postdiscal series two very pale purplish patches, white in centre.

6. Whereas in ♂ the dark brown *upf* reaches almost to the margin, in ♀ upf there is a lighter marginal and submarginal area, the inner edge of which corresponds to the outer edge of the postdiscal band below. This lighter area is continued *uph* as far as the tail. Also *uph* is a whitish discal spot, inward from tail, varying in obviousness.

J. A. YATES.

BANGALORE,
May 31, 1928.

[The female of *P. marshalli* was first described by Col. N. Manders. (*Ann. Mag. Nat. Hist.* London (6), 1910.) EDS.]

XXIV.—A SHORT NOTE ON A LYMANTRID CATERPILLAR (*DASYCHIRA MENDOSA*) (?) HUBN.[1] FEEDING ON MANGO LEAVES

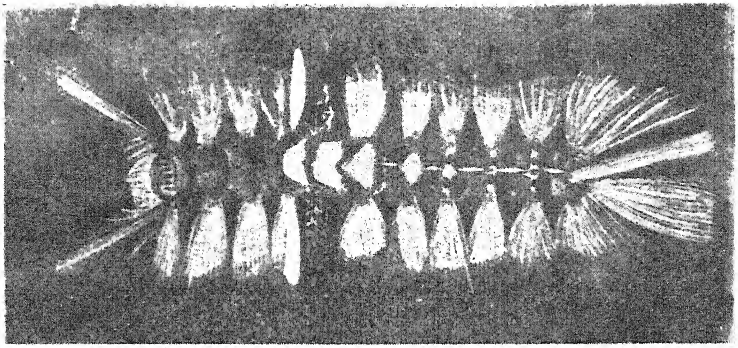
(*With a block*)

The Lymantrid larva, which is described below, was collected from a mango tree at Cossipore, a suburb of Calcutta, on March 13, 1928.

Description of the Larva.—Whereas in most other species of this group, the hairs are distributed more or less uniformly throughout the body, in the present species they are arranged in tufts, each segment bearing a pair in its lateral regions. These lateral tufts of hairs are long, erect and greyish-white in color. The general coloration of the body is mottled grey with red patches on certain segments. The head is somewhat oval in shape and bears an additional pair of long tufts of hair in its dorsolateral regions. The additional tufts in the head look very much like a pair of antennæ and these together with a similar tuft on the last abdominal

[1] Unfortunately, in the present state of our knowledge of the group, several species are mixed up under this name, and this note may prove an incentive to further research on the life-histories of Lymantrids.

segment may at times serve the purpose of frightening its enemies They usually remain projecting forwards making an angle of about 45° with the longitudinal axis of the body (see Fig.).



LARVA : (*Dasychira mendosa*) (?) HUBN

The first two thoracic segments are sub-equal and without any ornamentation. The third on the other hand possesses in addition to the lateral tufts, another pair of tuft of hairs which are white in colour. Dorsally the third thoracic segment bears an arc-shaped pad composed of creamy yellow pilose hairs.

In the first abdominal segment the lateral tufts are different in shape and structure from those of the rest of the body segments. They are short and greyish black mottled with white. This segment also bears dorsally an irregularly oval area similar to that of the preceding segment. The second abdominal segment bears dorsally a similar triangular pilose area, while on the third abdominal segment the triangulr pilose area is smaller than that on the second. Mid-dorsally a fine whitish pilose line runs backwards from the posterior edge of the creamy yellow pilose pad of the second abdominal segment to the middle of the last abdominal segment. The fourth, fifth and sixth segments bear mid-dorsally a transverse pilose band speckled with reddish pilose spots. The seventh or the last abdominal segment bears an additional pair of posteriorly directed tufts similar to the lateral ones.

The thoracic as well as the pro-legs are pinkish in coloration. The only larva that was collected measured roughly 30 mm. in length and 3mm. in breadth.

The larva in captivity was fed on young mango leaves and the full-fed larva pupated on the night of March 14, 1928. The pupal cocoon is oval in shape and brownish-white in color. It was spun in a top corner of the glass trough in which the larva was kept and is composed of larval hairs loosely gummed with a superimposed somewhat flimsy layer of loose silk. A few strands of loose silk irregularly gummed to the sides of the jar kept the cocoon in position. The cocoon was interspersed with larval frass.

The adult emerged on March 22, 1928, at night and has been presented to the Indian Museum Collection.

I have to record herein my thanks to Mr. T. Bainbrigge Fletcher, Imperial Entomologist to the Government of India, who so kindly identified the imago for me.

S. MUKERJI, M.SC.,
Zoological Survey of India.

XXV.—A PRELIMINARY NOTE ON THE POLLINATION OF THE CORAL TREE (*ERYTHRINA INDICA*, LAMK.)

(*With two plates*)

The observations recorded in this note were made by the writer during the months of February and March of 1926 and 1927, while at the Lucknow University. A detailed study of the plant with special reference to its pollination, will form the subject of another paper which will be published later.

There are only a few flowering plants which are pollinated by the agency of birds. The phenomenon involved is a very specialized one and is technically known as Ornithophily. The genus *Erythrina* —to which the popularly known coral-trees belong—is peculiarly interesting among the *Leguminosæ*, because in some of its species ornithophily seems to have been established. Delpino was one of the earliest investigators who supposed that cross-pollination in *Erythrina crista-galli*, a Brazilian species, takes place by the agency of humming birds.[1] Later Thomas Belt[2] established that in a species of *Erythrina* in Nicaragua, the fertilization was effected by humming birds.

This observation was followed by that of Trelease[3] who showed that in *Erythrina herbacea*, cross-pollination was carried on by ruby-throated birds. But as far as I am aware nothing adequately is known about the pollination of *Erythrina indica*, Lamk., which also seems to be Ornithophilous.

Erythrina indica, Lamk. (the *Parijāta* tree of the Sanskrit authors) is a native of Bengal near the sea,[4] but is now cultivated in gardens or on road-sides as an ornamental plant and is also ' largely planted as shade for coffee, etc. and as support for pepper '.[5] It is a big-sized tree and towards the approach of March it sheds all its foliage leaves and consequently looks altogether bare but the most prominent and conspicuous feature of the tree during this season, is the large number of scarlet-coloured flowers which occur in bunches,

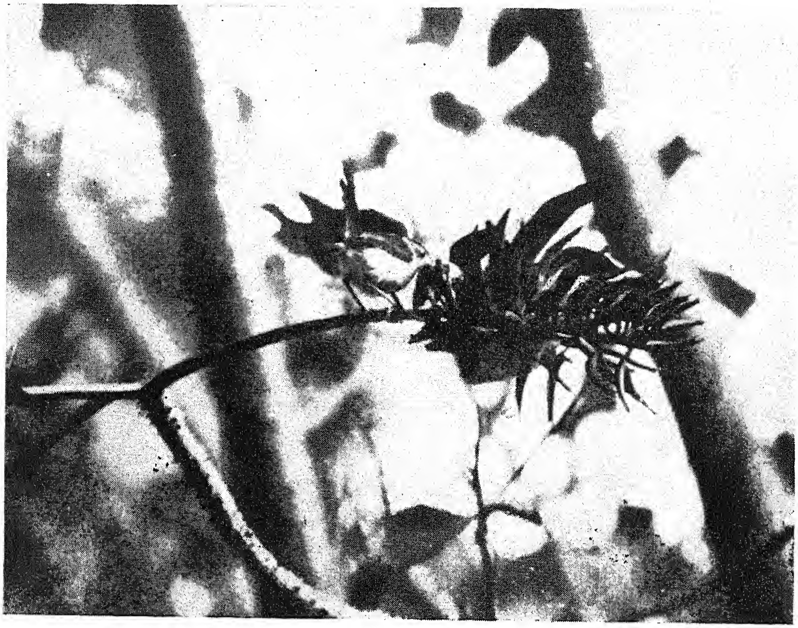
[1] Knuth, P.: (1908) *Hand Book of Flower Pollination* (English edition), vol. ii, p. 338.

[2] Belt, T.: (1880) *A Naturalist in Nicaragua*, p. 130.

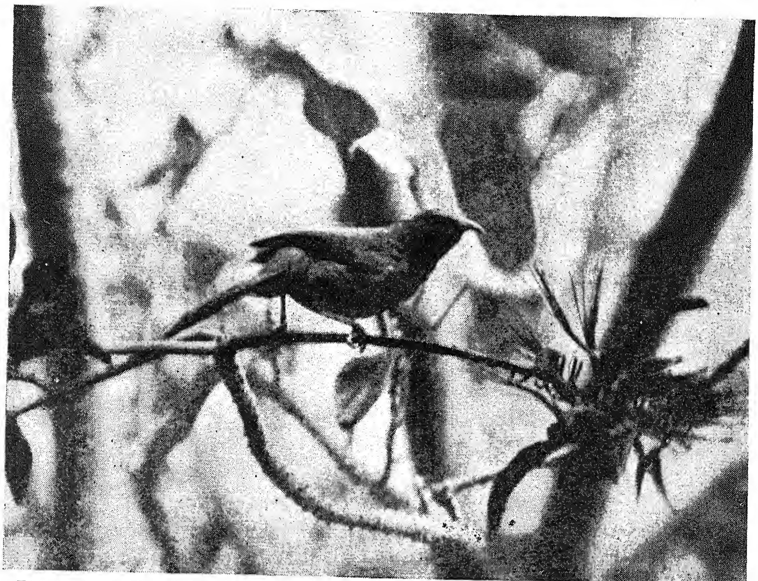
[3] Trelease, W.: (1880) ' Fertilization of Flowers by Humming Birds ' *Amr. Natur.* 14 : *pp*. 363–364.

[4] Watt, Sir George: (1908) *The Commercial Products of India*, p. 523.

[5] Willis, J. C.: (1919) *Flowering Plants and Ferns*, pp. 252–253.



The Tailor-Bird.
(*Orthotomus sutorius.*)



Photos by *Sálim A. Ali.*

The Jungle Babbler.
(*Turdoides terricolor.*)

SOME AGENTS IN THE POLLINATION OF *E. INDICA.*

Photos by Sálim A. Ali.

The Black Drongo.
(*Dicrurus macrocercus.*)

The Ashy Wren-Warbler.
(*Prinia socialis.*)

SOME AGENTS IN THE POLLINATION OF *ERYTHRINA INDICA*.

borne in a pendulous manner at the tips of branches in such great abundance, as to make the tree most attractive to look at, from a distance.

The inflorescence is a tri-chotomous cymose raceme and although it is borne in a pendulous manner, the flowers are all pointed upwards. The general structure of the flowers is similar (with minor differences) to that of *Erythrina crista-galli.*[1] The pedicels of the flowers are twisted at an angle of 180°. Thus the monoadelphous stamens together with the style are exposed towards the apparently posterior (virtually the anterior), side of the flower, the standard being a little deflexed outwards. The alæ are small. The margins of the carina (keel) tightly overlap each other and together with the closely fitted standard at the basal region form a conical sack which is full of sugary juice, secreted by the nectary gland, situated at the base of the gynœcium. This juice is sweet to the taste and is produced in such great profusion that when the flowers are in full bloom, a gust of wind often causes something of a mild shower of rain below the tree.

Amongst the birds, the Mynas (*Acridotheres tristis tristis*) are the most common visitors to this tree. Throughout the day, they may be seen hopping from one bunch to another in the act of sipping the sweet juice from the flowers—their fairly long beaks being of advantage in the process. In so doing, they naturally have to sit on the drooping branches and before they actually reach at the honey, their throat and beak invariably first touch the essential organs (andrœcium and gynœcium) of the flowers. Thus they unconsciously bring about the cross-pollination of the flowers by the transference of the ripe pollen grains (which remain sticking to their beak and throat) from the ripe stamens on to the mature stigmas[2]. For verifying this point some Mynas were captured alive and others shot, while in the act of sipping the sugary juice. It was found that the pollen-grains which were observed sticking to their beak and feathers were identical—on microscopic examination—with the pollen grains of *Erythrina indica*, Lamk.

Several observations made during the different hours of the day, have convinced me that in keeping with their habit,[3] it is during the hours of 4.30 p.m. and 6 p.m., that one sees them thronging on the tree in large numbers; consequently this seems to be the most favourable time for pollination. An observation with powerful field glasses is specially interesting in watching the intelligent way in which they carry on the whole process. No insects, ants or butterflies have been noticed, thus excluding any suspicion of their (the Mynas) visiting the flowers for the sake of catching them to feed upon. However sometimes crows, parrots, etc., may be seen on the tree but they act like thieves and steal away the honey as they often do in the case of *Bombax malabaricum.*

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[1] Knuth, P.: *loc. cit.*

[2] Also self-pollination taking place simultaneously, may be possible.

[3] Bainbrigge Fletcher, T. and Inglis, C.M.: (1924) *Birds of an Indian Garden*, p. 53; Stuart Baker, E. C.: (1926). *The Fauna of British India*, vol. iii, p. 54.

Thus the available facts all seem to show that the pollination of this interesting Leguminous plant is carried on by the Mynas (*Acridotheres tristis tristis*).

In conclusion I have great pleasure in expressing my sincere thanks to Mr. T. Trought, Cotton Research Botanist, Lyallpur, for kindly reading through the manuscript and other facilities which he readily provided during the course of the preparation of this note.

T. C. N. SINGH,
Microscopist,
Cotton Research Laboratory, Lyallapur.

LYALLPUR,
May 17, 1928.

[A far greater variety of birds are regular habitués of the coral tree (*Erythrina indica*) in bloom and contribute to its pollination than appears to have been observed in Lucknow. Among the birds to be invariably met on the flowers in this part of the country, in addition to the Myna and the Crow, may be mentioned the Rosy Starling (*Pastor roseus*), Babblers (*Turdoides*, *Pyctorhis* and *Dumetia*), Drongo (*Dicrurus*), Wren Warblers (*Prinia socialis* and *inornata*), Tailor Bird (*Orthotomus sutorius*), Bulbuls (*Otocompsa*, *Molpastes*, *Pycnonotus* and *Chloropsis*), Grey and Black-headed Mynas (*Sturnia* and *Temenuchus*), while we have frequently noticed the Black-capped Blackbird (*Turdus merula nigropileus*) and the Tree Pie (*Dendrocitta*). A Coral Tree in flower is in fact a rendezvous for almost every bird of the countryside, most of whom feed on the nectar and unconsciously promote pollination. Purely insectivorous species, though doing no such service, are also invariably present in the vicinity for the sake of the visitant insects. EDS.]

ANSWERS TO CORRESPONDENTS

E. L. S.—*What is the effect of castration on horned animals?*

Experiments carried out with domestic animals and with wild animals in captivity have revealed the effect of castration on the development and growth of horns. It is first necessary to distinguish between animals in which both sexes carry horns and those in which horns are confined to the male. In breeds of sheep where horns are developed by the males alone, castration has a direct effect on horn growth. It has been shown by experiment that young rams of these breeds never develop horns if castrated. In breeds of sheep in which both sexes are horned, castration has no effect whatsoever on the development and growth of the horns. A parallel effect is seen in deer, though here the question is slightly complicated by the fact that the antlers are shed annually. As with sheep, castration has no effect on reindeer as both sexes carry antlers. If a stag of any other species is castrated early enough antlers never appear. If castrated rather late, when the horns have begun to grow, but before the velvet has been 'shed', they never develop properly. The velvet covering then persists, the horns become small and misshapen and are never cast off. If a stag with fully developed horns is castrated his antlers are soon thrown off. They are either never replaced or are replaced by malformed antlers. The question as to whether injury to the testes suppresses the growth of antlers or horns depends largely on the extent of the damage. Experiments in partial castration have shown that a fragment, only one hundreth the size of the two testes, suffices for the complete development of the sexual characters. If, however, the amount of the testicular substance be even very slightly less than the minimum, the sexual characters do not develop at all. It is believed that intermediate amounts of testicular substance would produce intermediate results but this has still to be proved by experiment. A curious effect of castration on a Blackbuck has been indicated by Mr. Wilson (*Journ.*, vol. xxii, p. 622) and Capt. C. R. S. Pitman (*Journ.* vol. xxii, p. 575). In both cases castration resulted in a change in the colour of the coat. The rich black coat of the gelt buck faded to fawn, which is the colour normal in does and immature males.

A. J.—*How many species of cobras are there in India? Is the black cobra a distinct species? What is the general distribution of cobras?*

Only two species of cobra occur in India—the King Cobra (*Naia bungarus*) and the Common Cobra (*Naia tripudians*). Like the King Cobra, the Common Cobra varies considerably in colour and markings. The various recognized forms of this snake might be regarded as distinct species but for the absence of any sharp lines of demarcation between them. In many parts of India, in the United

Provinces, Sind, Rajputana, the Punjab and the southern portion of the Malay Peninsula the cobra is commonly uniformly black, with no apparent markings on the hood. This colour form is known as *cæca*. In many black cobras the black markings on the hood escape notice, unless especially looked for. In some, the hood markings are limited to a few spots, in others there is a modified form of spectacle and in others again the spectacle is as perfect as in the typical cobra (var. *typica*). Thus we have black cobras that are scarcely distinguishable from the typical form and many intermediate variations which cannot be identified with the *black* or the *typical* variety. It has been suggested that a method based on lepidosis i.e. on the number and arrangement of the scale rows, the ventrals and subcaudals would provide a better means of differentiating between the various forms of cobras. The cobras of South India generally have 23-25 scale-rows in the mid-body, while in the Punjab the scale rows are limited to 21. But actual investigation has shown that differentiation based on these characters alone does not yield consistent results, though it provides, to some extent, a means of grouping these snakes more in accordance with their geographical distribution. Cobras are restricted to Southern Asia and Africa. Eleven species are recognized. Our Common Cobra has a wide distribution. It ranges from Transcaspia to China and the Malay Peninsula. Other Asiatic species are *Naia morgani*, which has been recorded from Persia and Mesopotamia, *Naia samarensis* of the Philippine Islands, and the King Cobra (*N. bungarus*) which is found through the forest tracts of India, Burma, Southern China and the Malay countries. *Naia haje* the ' Aspis ' has been recorded from Southern Palestine. The last named species is widely distributed in Africa. In addition to *N. haje* the genus *Naia* is represented by 7 species on the African Continent—*N. flava*, *N. nigricollis*, *N. melanoleuca*, *N. anchietae*, *N. goldi* and *N. guntheri*.

W. J. W.—*What is the longest known migratory journey performed by any bird?*

Birds are great travellers. Many species undertake enormous journeys to and from their breeding haunts, i.e., between their summer and winter quarters. It has been clearly established from recoveries of ringed birds, that Swallows from Great Britain migrate to South Africa, a distance of nearly 6,000 miles ' as the crow flies '. Much remains to be learnt regarding the routes taken by the birds and it is therefore quite possible that we may have to add several hundred or even a thousand miles to this figure when further information becomes available!

The White Stork (*Ciconia alba*) is another well-known traveller. Birds breeding in Denmark, Germany and Hungary find their way to South Africa to ' winter ' there in the southern summer.

In this sphere, however, the palm must indisputably go to the Arctic Tern (*Sterna macrura*). In the Northern summer this bird is not found south of about 40° N. lat., but is known at this season to reach as far north as 82°. Yet in winter the Arctic Tern's range

extends to the Antarctic, where it has been seen as far south as 72° S. lat. It is evident therefore that while 6,000 or 7,000 miles may ordinarily constitute a single migratory journey of this bird, as many as 11,000 miles might not infrequently be covered during the move from the Arctic summer right across the world to the Antarctic summer.

R. L. E.—*Where do bees obtain the wax with which they build their combs.?*

The production of wax by social bees and of a substance similar to wax by certain solitary species, appears to be the result of the great amount of sugar consumed by these insects. Similar exudates are produced by such far removed insect forms as the scale insects, aphids and lantern flies (*Fulgorids*) which live on the sap of plants and consume so much sugar that they have to rid themselves of much of it in their fæces. Again it has been discovered, strangely enough, that the larva of certain lady-bird beetles (*Coccinelidæ*) which feed exclusively on sap-sucking aphids also produce abundant exudations of wax. In the honey bees only the young workers produce wax. It is secreted in glands situated in the hind body of the bee. The wax makes its appearance on the lower surface of the insect's abdomen, passing from the interior of the body through thin, projecting, plate-like membranes. The bee removes the wax with an apparatus on the hind pair of legs and, after working it up with its mandibles, applies it to form the cells in which the young bees are to be reared and the food stored. A large number of bees working together thus produce the regular and beautiful structure known as the comb. Although wax is now exclusively used in comb building, the question arises whether its use as building material may not have arisen originally from its use by the immediate ancestors of the higher social bees as a provision of food for their larvæ. Earlier observers have claimed that the pollen paste, a mixture of pollen and wax in which the queen humble bee (*Bombus*) lays her eggs, is devoured by the larvæ. Recent investigations have been unable to confirm this point. Elaboration of the suggestion that the ancestors of the three higher groups of social bees fed their larvæ on fatty exudates would be therefore in the present rudimentary state of our knowledge pure speculation.

As stated previously, wax is also produced by other insects. With some of the aphids its purpose appears to be protective. The wax—this has nothing to do with the 'honey dew' or 'milk' which is so attractive to ants—oozes from two wart-like tubercles situated near the end of the aphid's body. On reaching the air the liquid issuing from these tubes stiffens almost instantly into a wax-like mass. When attacked by the larva of a lady-bird beetle an aphid has been observed to set its tubes in motion and to besmear the head of the attacker with a discharge of sticky fluid. Waxy matter is also produced by several Coccids or Scale insects.

This white insect wax has a certain commercial value in India and China. The *Fulgorids*, a large family of sap-sucking insects

which includes the so-called lantern flies (in which the head is produced to form a huge misshapen proboscis), secrete large quantities of white flocculent wax. This wax forms the favourite food of certain butterflies. It is used by the Chinese for candles. Its exact use to the insects themselves has not been ascertained.

A.F.B.—*Are there carnivorous plants in India? How do they absorb food?*

About 400 species of carnivorous or insectivorous plants have been found all over the world. They belong to the following families: Droseraceæ, Cephalotaceæ, Lentibulariaceæ, Nepenthaceæ, and Sarraceniaceæ. Of the 400 species about 50 are indigenous in British India (including Ceylon, Burma and the Malay Peninsula). The following families are represented:—

1. Droseraceæ. Only 2 genera are indigenous in India, Drosera and Aldrovanda.

   Of Drosera 3 species are found practically all over India: *Drosera Burmanni* Vahl, *D. indica* Linn., and *D. peltata* Sm. They all go under the name of Sundew. In these species the leaves are spoon-shaped or linear or half-moon-shaped. They are set with curious tentacles, i.e. with rather stiff hairs ending in swollen reddish heads which secrete a sticky glistening fluid. Flies and other insects mistaking it for honey are held by it. The tentacles are exceedingly sensitive to continued pressure even by the slightest bodies. The result is to cause an inward and downward movement of the head of the tentacle, finally placing the insect upon the blade of the leaf. At the same time the stimulus passes to the neighbouring tentacles causing these also to bend downwards to the same point. The victim is thus smothered and now the glandular heads of the tentacles secrete a ferment which acts upon the proteids and brings them into solution, when they are taken up by the leaves. The food thus absorbed is of benefit to the plant, though it can live without it.

   Of the other genus Aldrovanda only one species is known, *A. vesiculosa* Linn. It spreads from Europe to Australia and is also known from India. It is a rootless swimming plant with whorls of leaves. Each leaf has a stalk portion and a blade like Venus' Fly Trap, working in the same way, capturing and digesting small animals.

2. Lentibulariaceæ, represented by 2 genera in India: Utricularia and Pinguicula.

   Of Utricularia (Bladderwort) about 210 tropical and temperate species have been observed, in India alone about 30. The Indian species are badly in need of revision. Some live in water, others are land plants, and some again are epiphytic. As the name implies the plants bear on their leaves or on peculiar runners the so-called bladders which are curious hollow structures with trap-door entrances.

Small crustaceans and other animals push their way into the bladders and are not able to escape, for the doors only open from outside. The plant takes up the products of the decay of the organism thus caught. It is very doubtful whether any special ferment is secreted. We possess very few observations regarding the physiological part of food-absorption in Indian species.

Pinguicula or Butterwort is the other genus of Lentibulariaceæ. We know 30 species, but only one from India, viz. *P. alpina* Linn. or Alpine Butterwort. It is an inhabitant of the alpine Himalaya, but occurs also in Europe and North and Central Asia. It has a rosette of radical leaves which are covered with glands secreting a sticky fluid to which small insects adhere.

3. Nepenthaceæ or Pitcher Plants.

This family contains only 1 genus with about 60 species, all belonging to the tropics of the Old World. In the botanical region of India, chiefly in the Malayan Peninsula, there are about a dozen species. They are mostly herbs growing in boggy places and climbing by aid of tendrils which are prolongations of the leafmidribs. The end of the tendril develops as a rule into a pitcher, with a lid projecting over the mouth, but not closing it except in the young state. The edge of the pitcher is curved inwards. At the entrance are numerous honey-glands, and for some distance below it are other glands, sunk in little pits on the inner surface. Insects attracted by the honey or by the bright colour gradually work their way downwards among the glands, and presently get upon the slippery lower part and ultimately into the water at the bottom of the pitcher, where they are drowned. The plant absorbs the products of their decay.

PROCEEDINGS

Opening of New Museum Groups by His Excellency the Governor on November 22, 1928.

(With two plates)

In spite of his very numerous engagements, Sir Leslie Wilson who throughout his tenure of office has shown the keenest interest in the progress and development of the Museum and of the Natural History Society of which he is the President, visited the Natural History Section on Thursday the 22nd instant to see and open to public exhibition the remarkable series of groups, prepared by the Curator and staff. His Excellency was received at the entrance to the Museum Building by Mr. G. A. Thomas, C.I.E., I.C.S., the Chairman and the Trustees of the Museum and by the Executive Committee of the Bombay Natural History Society.

There was a large and distinguished gathering of representative citizens who were invited to meet His Excellency and to look over the new groups.

In opening the proceedings and in inviting His Excellency to inspect the groups, Sir Reginald Spence, Chairman of the Committee of Trustees of the Natural History Section and Honorary Secretary of the Society outlined the plans for the development of this Section of the Museum.

Sir Reginald Spence said :—

' Your Excellency,

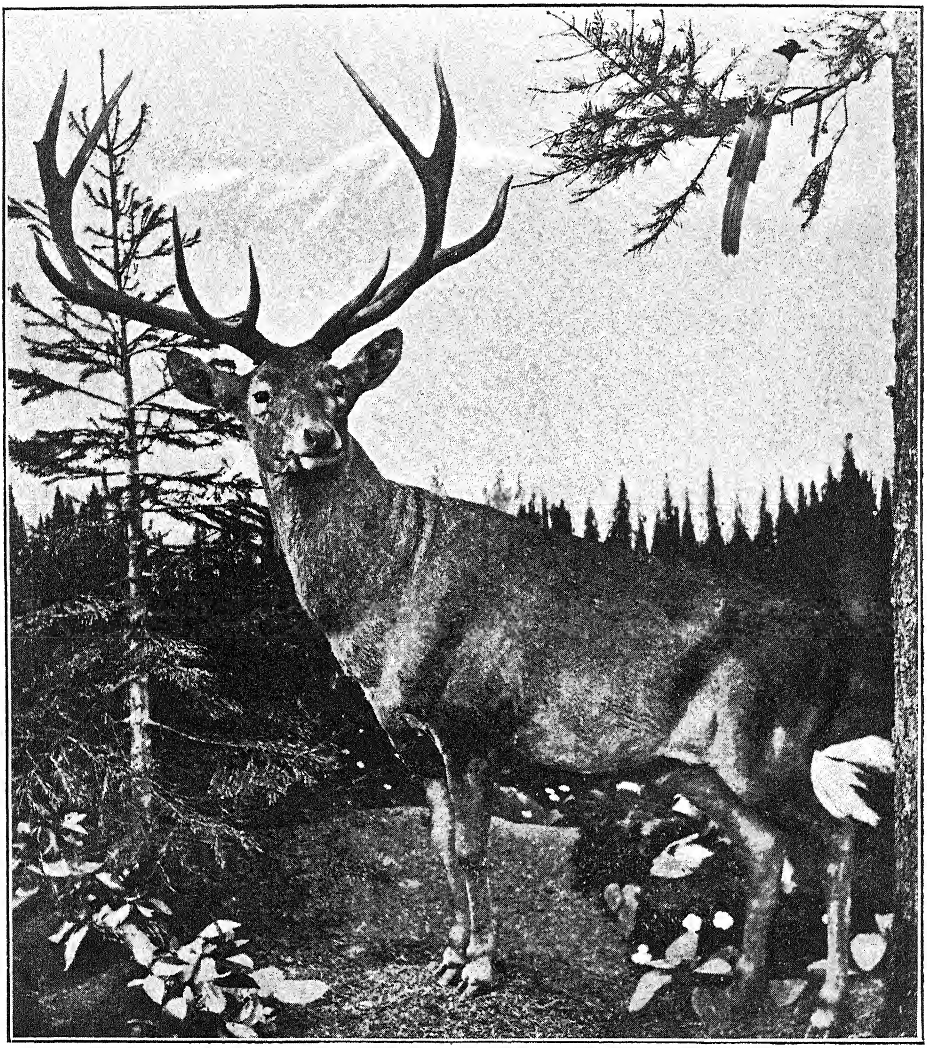
I am afraid I am notorious for long speeches and therefore whilst I should like to be the channel of communicating our thanks to you for your presence amongst us and for the help you have given to the work of the Museum and our regret at your approaching departure, I will leave this to others and try and concentrate on the object of our meeting to-day which I think is to demonstrate what Swadeshism—properly applied—can do for India and the City of Bombay in particular. This is not a political meeting nor is evidence being given before the Simon Commission, and I am therefore emboldened to give a definition of Swadeshism, a definition which is applicable to any country and any race. Swadeshism, in my opinion, means the gathering of the knowledge and experience of other countries and applying that knowledge and experience for the benefit of your own country by means of your own people who have taken advantage of the experience and knowledge of those other countries.

I give this definition because this Museum and today's ceremony are a proofs of its correctness. The East has learnt from the West the value of Museums, and through the generosity of Bombay citizens has taken advantage of that knowledge. The inception of the Prince of Wales' Museum may have come from the West, from your distinguished predecessor Lord Lamington, but the idea was turned into reality by the generosity of the people of India—I will only mention at the moment the names of the late Sir Currimbhoy Ebrahim, the members of the Tata family, and Sir Cawasjee Jehangir.

Coming from the Museum as a whole to the Section of it we are concerned with to-day, the exhibits which Your Excellency is about to open have only been made possible through the East learning of the West and through the generosity of the East and the skill and aptitude for absorption displayed by those born in and belonging to this great City.

From the Museums of the West we have learnt what a great aid to education, what a great source of pleasure, a Museum can be, but had it not been for the skill and assiduity of the people of the East we could not have demonstrated to the people of the East what we had learnt.

THE KASHMIR STAG (*Cervus hanglu*)



Group exhibited in the Prince of Wales' Museum, Bombay.

Stag shot and presented by
Col. R. W. Burton

Group presented by
Sir David Ezra, Kt.

We have a great deal more to learn—we have to learn the truth, so well demonstrated in America, that it is the duty—because it is for the good of the country—of the citizens of a State to make the Museums of their State as much the object of their care and assistance as they do or should do their Hospitals and their Schools. If the sole financial responsibility for the maintenance and equipment of Museums is left to Government, or the Municipalities, we shall remain in the unfortunate impasse at present created by the decision of Government to curtail its grant to this Museum and its inability to carry on the educational work in the schools of Bombay commenced, owing to the generosity of the late Sir Sassoon David, by the Natural History Section of this Museum. Our object to-day however is not to criticise Government or the Municipality—after all we owe them thanks—but to express our gratitude to the private citizens who have made these exhibits possible and, through these exhibits, to appeal to other citizens.

In America it is the right thing for private citizens to spend money on Museum work and so we have the Vernay-Faunthorpe expeditions to this country to obtain for the great Museums of America material to enable the citizens of the United States to see for themselves—shown in their natural surroundings—the fauna of this great country. But thanks to the generosity of Mr. Vernay and the kindness of American Museum authorities, men of India—of our own city—have been given—and have taken advantage of—opportunities to learn how to give to the people of India the same advantages, as through the generosity of her private citizens, the people of America enjoy.

I will leave to the Curator, Mr. S. H. Prater, any word painting if such be necessary, and I do not think it is, of our exhibits. I wish merely to emphasize the fact that what we see to-day is but a fraction of what would be possible if the citizens of Bombay would take the same personal interest in the Museums of this City which is taken in America. We have the material, we have the site, we have the men, and, thanks largely to the first Sir Currimbhoy Ebrahim, we have a portion of the money which, added to, will give this City a Natural History Museum the finest in the East and so worthy of Bombay, which will enable the Arts and Archæological Sections of the Museum—like our Section at present cribbed and confined but I am glad to say not coffined—to do for this City and to be to this City what they were intended to be—worthy of it.

May I in conclusion express the thanks of the Committee of Trustees of this Section to the Trustees of the late Sir Sassoon David—to Sir David Ezra a citizen of Calcutta, to Mr. Evans at one time a resident in this City and to Mr. Vernay—merely a passer-by—for their financial assistance, and to Mr. Prater and his assistants, Messrs. McCann, LaPersonne and Salim Ali and to Mr. K. B. Savardekar for the way in which they have taken advantage of that assistance and made to-day's meeting possible. Also to Mrs. Sanderson, the wife of my colleague, for the beautiful wax flowers made by her which are used in the groups.

I will now ask Your Excellency to unveil the cases and Mr. Prater will explain if desired any point in connection with the structure and purpose of the groups.'

His Excellency was then conducted over the Galleries by Mr. S.H. Prater the Curator who explained in full the purpose of the various exhibits.

The new groups illustrate the most modern phase of Museum development. They are all constructed on the lines of a diorama, with curved backgrounds. This mode of scenic representation is now being generally adopted by the more advanced Museums of Europe and America. By a combination of transparent and opaque painting, of reflected and transmitted light a diversity of scenic effect is produced. Besides illustrating the fauna and flora of the country, these groups reveal something of the charm of India—India with its wonderful vicissitudes of climate and physical characters.

The three groups now completed in the Museum illustrate a South Indian Hill Range with its wealth of animal and plant life, a view in the Liddar Valley, Kashmir (a summer haunt of the Kashmir Stag, a grand specimen of which is seen in the group) and a view of the Sind Desert. They are one of the 'Show Sights' of the City. An important exhibit, seen by His Excellency, are the cases illustrating the life history of *Anopheles stephensi*, the Malaria-carrying mosquito of this City, and of *Stegomyia fasciata*, a Culicine species which does

not carry Malaria. The exhibition of these cases coincides with the publication of Major Covell's important report on Malaria in Bombay and the methods of eradicating the disease. These cases represent the Museum's contribution to the education of the public in a matter which intimately concerns their health and livelihood. A Mosquito enlarged 28 times reveals its structure and its armoury of weapons; enlarged models of the egg, larval and pupal stages of these insects are also shown. They are the excellent work of Mr. P. F. Gomes of the Museum staff. Accompanying the cases are maps, one prepared by Dr. Bentley in 1912, the other by Major Covell in 1928. They graphically illustrate the northward spread of the disease in this City. The cases and their exhibits were presented to the Museum by Mr. F. V. Evans, Vice-Patron of the Bombay Natural History Society and a most generous benefactor of the Museum. Mr. Evans' generosity has also enabled the Museum to undertake the preparation of a series of beautiful models in wax illustrating the fishes of our local waters. Incidentally these exhibits reveal the great variety of food fishes which are to be had in our local markets. In this connection the Museum is indebted to Mr. Esuf Hassam, a prominent fish merchant of Bombay, for presenting the specimens from which the models were made. They are the work of Mr. Wandrekar of the Society's staff who has shown the greatest skill in their preparation.

After inspecting the various exhibits His Excellency addressed the gathering.

Sir Leslie Wilson said :—

'Sir Reginald Spence, and Trustees of the Prince of Wales' Musuem of Western India

Although my visit here this afternoon is necessarily a very short one, I am greatly indebted to you for inviting me to see the very interesting exhibits which I have just had the pleasure of unveiling and inspecting. These beautiful groups, which are now open to the public, are in part the result of the policy of the Committee and the Trustees in enabling the Curator to visit and study in the Museums abroad, and I feel sure that these improvements will commend themselves to the public for whose pleasure and profit they are intended.

For the first group the Museum is indebted to the generosity of Mr. Vernay, who permitted the members of the staff to join the Vernay-Faunthorpe Expedition, and so enabled the Museum to collect the material and paint studies for the background of this group. It illustrates animal and plant life in the South Indian Forests, and, from my own experience I can say that it is a most lifelike and realistic representation. It is not everyone who can afford the time and the money to visit the forests of Southern India, but it is now open to any citizen of Bombay, at the cost of no more than a tram fare, to come here and get for himself some idea of the interest and beauty of a South Indian jungle.

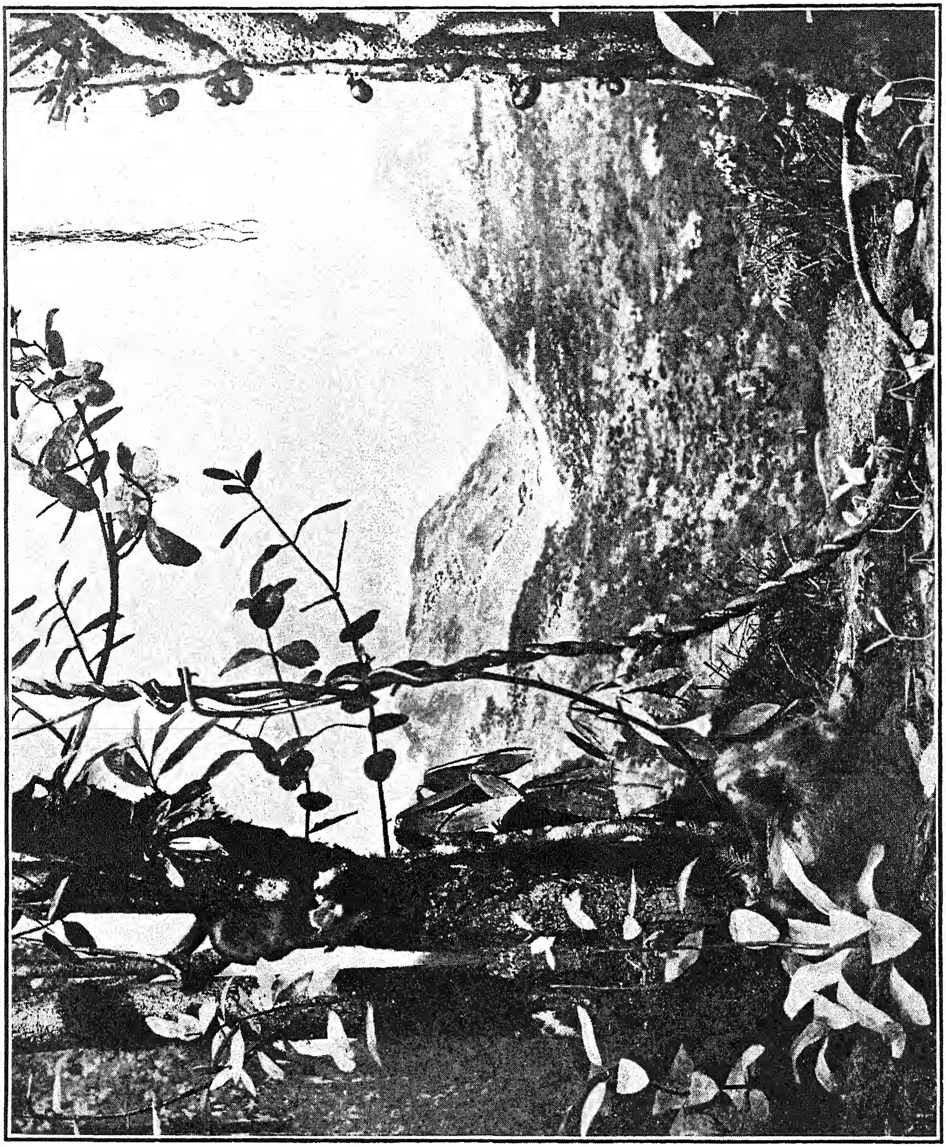
The second group has been presented to the Museum by Sir David Ezra, one of the Vice-Patrons, and shows the haunts of the finest Indian Deer, the Kashmir Stag, with a distant view of the valleys and mountain peaks of the Himalayas

The third group, which has been presented by His Highness the Maharao of Cutch, illustrates animal and plant life in the Indian Desert, and reveals the harmony of colour between the desert animals and their environment. It shows a portion of desert country, in the Larkana District of Sind, and gives a view of the sand dunes and thorn-covered wastes and barren limestone hills with which those of us who have visited Sind are so familiar. All three groups reveal something of the varying physical characters, the sharp contrast of climate, and the beauty of different parts of this country, using that beauty, which is universal in its appeal, as a means of arousing the interest and attention of the visitor.

Anyone who carefully studies these groups will acknowledge the brilliant work of Mr. Sawardekar, the Museum Artist, to whose skilful and painstaking work in painting the backgrounds the success of these exhibits is largely due. I should also like to congratulate Mr. Charles McCann, Mr. V. S. LaPersonne and Mr. Gilbert for the preparation of the various plant forms, trees and other accessories in wax. Their work has added greatly to the realism of these groups, and their skilled craftsmanship must be seen to be fully appreciated. The beautiful representations of orchids and other flowers prepared by Mrs. P. M. D. Sanderson have added greatly to the beauty of these exhibits.

I need not refer at length here to the smaller groups and cases, which contain so much to interest both the scientist and the casual visitor. Here one is able

THE BILLIGIRI-RANGAN HILLS, SOUTH INDIA



to study the habits of Indian snakes, as well as the life and development of mosquitoes—an intelligent study of which should do much to help the public of Bombay to get rid of one of the most serious menaces to life and health in this city. The generosity of Mr. Evans has also enabled the Museum to undertake the preparation of a series of beautiful models illustrating the fish of our local waters, and the Trustees have reason to be grateful to Mr. Esuf Hassam, a prominent fish merchant of Bombay, who has generously presented the specimens from which these models have been made.

Any visitor to this Museum will, I think, entirely agree with the Trustees that it is now quite time to extend the accommodation available, and will cordially endorse their decision that the most satisfactory solution would be to remove the whole of the Natural History Section from the present building to a new wing, and to confine the existing building to exhibits of Art and Archæology which are at the present time badly overcrowded. For this purpose additional funds are required, and I sincerely trust that there will be a generous response from the public, so that this can be done at an early date. As Sir Reginald Spence has pointed out, the work in the Museum is being done by Bombay men for the benefit of Bombay people, and only a comparatively small effort is required to carry out the plans of the Trustees, which will make this Museum, in Sir Reginald Spence's words, the finest in the East, and consequently worthy of the City of Bombay.

I feel sure I am only giving expression to the sentiments of all the Trustees and of the visitors to this Museum in very warmly congratulating Mr. Prater, the Curator, on the excellent work that has been done by him and by the staff of the Museum. I have had many opportunities of seeing Mr. Prater work, and I can personally testify to the zeal and energy, coupled with great ability, with which he labours so hard for the Museum. I need say no more about his work, for it is all around you for you to appreciate it yourselves. I must again express the hope that the appeal which the Trustees are making for additional funds will receive the support that it deserves, and that Mr. Prater and the Trustees will have an early opportunity of bringing about that extension and improvement which will make the Prince of Wales' Museum, even more than it is at present, a source of pleasure and profit to our citizens, as well as an outward expression of the culture and enterprise of Bombay.'

Printed by George Kenneth at the Diocesan Press, Madras and published by
R. A. Spence for the Bombay Natural History Society, Bombay

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